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Work Under Way on Pennsylvania Turnpike—Longest Toll Superhighway in the United States
Old Railroad Fill and Tunnels Utilized in New Construction Between Harrisburg and Pittsburgh

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FEBRUARY 1940

Among Our Writers

ROBINS FLEMING has had a long career in structural steel design. Since his retirement in 1931 he has applied himself to his hobby of library research, and has contributed a wide variety of brief articles to the technical press.

HERSCHEL H. ALLEN has been associated with John E. Greiner, Hon. M. Am. Soc. C.E., since his discharge from the Army in 1919. He is now a member of Mr. Greiner's firm and actively engaged in supervision of design and construction of bridges and other projects in the eastern United States.

J. A. VAN DEN BROEK (B.S. in C.E., U. of Kansas, 1911) has been on the faculty of the U. of Michigan, Department of Engineering Mechanics, since 1914. He is the author of *Elastic Energy Theory* (1931) and a number of papers in the technical press, including "Theory of Limit Design" in PROCEEDINGS, February 1939.

HARRY A. CIUFI has been in engineering work since 1915, except for service in France. He was for 7 years with the Board of Transportation, New York City, and the Transit Bureau, Newark; spent 4 years in private practice; 3 years with the U.S. Engineers; and since 1934 has been with PWA as resident engineer inspector; including 2 years in Hawaii.

FREDERICK W. DOOLITTLE from 1923 to 1936 was an officer and director of the North American Company and of many of its subsidiary companies, with general supervision of programs and budgets. In 1936 he resigned as an officer, but continues as director and consultant for the company and as director of certain of the subsidiaries.

GILBERT C. DOBSON (U. of Missouri, 1905) has had experience in construction and design on the Panama Canal, terminal track work in Kansas City, military engineering during the World War, concrete technology with the Portland Cement Association, flood-control investigations with U.S. Engineers, and sedimentation research with the Soil Conservation Service.

JOE W. JOHNSON (U. of California, B.S. in C.E. in 1931, and M.S. in Irrigation Engineering in 1934) was with the U.S. Waterways Experiment Station, Vicksburg, 1934–1936; and from 1936 has been with the Soil Conservation Service on transportation of sediment research studies.

RALPH BUDD, president, C.B. & Q.R.R., and in railroad service since 1899, has taken a leading part in advancing the use of light-weight railroad equipment. Prior to 1932 he was president of the Great Northern, and responsible for its Cascade Tunnel and electrification.

J. O. OSTERBERG (Columbia U., 1935) has an M.S. from Harvard U., and a Ph.D. in civil engineering from Cornell, where he studied as a McMullen Research Scholar, doing special research on methods of measuring soil pressure. He is now with the U.S. Engineers at Vicksburg, Miss.

F. P. DILLON (U. of Illinois, 1906) started in the Lighthouse Service as Assistant Superintendent in 1911. He has served in various districts since then, and when the Service was consolidated with the Coast Guard in 1939, he was commissioned Commander on the staff of the District Commander at Cleveland.

OSCAR S. BRAY (U. of Cincinnati) began his engineering work as a rodman with the Lackawanna R.R. and later worked as inspector during construction of the Cincinnati Union Terminal. With the National Park Service since 1934, he is presently attached to the office of its chief of engineering.

F. M. S. JOHNSON (U. of Washington; also D. Eng., Colorado School of Mines) was a structural engineer with the Interstate Commerce Commission previous to entering the Corps of Engineers in 1917. Now a major, he is assistant division engineer of the South Pacific Division, on river and harbor improvements and flood control projects.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Compensations for Days of Retirement

By Robins Fleming

Structural Engineer, Retired, New York, N.Y.

RETIREMENT these days comes to the engineer earlier than it once did. Then, too, reversing a well-known witticism, "People are living today who never used to live before," that is, they are living longer. Take these two factors together, and the net result is an aggravated problem for the person concerned.

Many a man has found himself "retired" when he was able to continue his work. Again, physical disability may have set in. He may or may not be regarded as an "old" man. Just here, let a sharp distinction be drawn between growing old and growing older. A man cannot help growing older; he may be able to defer growing old indefinitely. Old age has been defined as the inability to accept anything that is new.

Time May Hang Heavy.~Invariably the question comes to every one that is past the meridian of life or has laid aside its workaday activities, "What shall I do with my time?" One result is certain—he will have an opportunity to think. From such an experience, and the vantage point of eight and a third decades of living, a few stray thoughts will be presented with the retired engineer in mind.

A lady troubled with poor eyesight was advised by her physician that she would probably be able to see for a year or so longer but would eventually become blind. The woman during the time that she could read committed to memory the entire book of Psalms and thus had them to draw upon in the period of her blindness. Her example, in principle, could well be followed. Choice pieces of poetry or prose committed to memory are an excellent investment. They may soothe troubled hours of the day or wakeful hours of the night. Several years ago I met one of the leading, perhaps the very foremost authority on dam construction. "What are you doing now?" I asked. "I am 81 years old and am studying calculus," he replied. The study of quaternions is suggested to the retired engineer with a mathematical leaning, although perhaps it will require a super-mathematical ability.

Writing for Diversion.~A college professor, author of a widely known textbook, after his retirement wrote to me that he was revising his book. "It is a pleasure," he remarked, "to take as much time as I please on this work without other responsibilities." The probability is that in the course of this work, new views on familiar subjects would be opened up to him and he would be tempted to follow them in his revision beyond space limitations.

Retired engineers are sometimes urged to present their best thoughts to the technical press. If they decide to offer a contribution, they should be prepared to have it returned as not available, "not from lack of merit," as rejection slips often say, but for other reasons. The pressure on the columns of engineering periodicals is tremendous.

Why not write for the purpose of acquiring knowledge? As some one has said, if you really want to understand a subject, write a book on it. A particular phase of a subject that is not clearly understood may be clarified by an effort to write explaining it—not necessarily with publication in view. Incidentally, many a published article has sprung from an effort on the part of the author to clear up his own thought on some particular subject.

Fascinations of Mathematics.~Consider the average engineer, who, having reached the retiring age or from other reasons, is "laid off" or, if in business for himself, is having his practice taken by younger men. He may not be interested in the calculus, though the differential calculus has been called the most beautiful poem that ever entered the mind of man. He may merely have heard of quaternions.

However, there are less difficult subjects of interest. There is, for example, the logarithm—not necessarily the presentation in textbooks but the line of thought of Napier himself. Why are certain logarithms called natural or hyperbolic? One looking for mathematical recreation will find plenty of it if he will only approach the logarithm the way Napier did. Mayhap, as Chrystal says in his *Algebra*, he will gain a truer "conception of the penetrating genius of the inventor of logarithms."

In the popular Everyman's Library *The Elements of Euclid* is now included. Sir Thomas Heath, a British mathematician of note, has written the introduction. In it he says, "Any intelligent person with a fair recollection of school work in elementary geometry would find it (progressing as it does by gradual and nicely contrived steps) easy reading, and should feel a real thrill in following its development, always assuming that enjoyment of the book is not marred by any prospect of having to pass an examination in it." The reader may

not find it "as difficult as any detective story to lay down" but he can hardly fail to find it interesting if he will make the trial of reading it in the manner described.

In the same way textbooks of student days could be reread. One of physics would prove to be of interest, especially if followed by a text of recent date. Time could well be devoted to a study of the application of physics to industry and everyday life. One textbook presents more than 1,400 problems in this field.

Reading for Culture.~Technical articles can be read in a more leisurely way by the retired engineer than by one in active practice. He even has time to check equations and need not take it for granted that they are true. Better still, he can widen the range of his reading, employing the enormous resources of the libraries in our schools and cities if he is so fortunate as to have access to them. Time need not hang heavily on his hands. If he has a hobby, whether it be the fourth dimension or sweet pea culture, he will be surprised at the mass of available writings on the subject.

A widely known technical and business man asked, "Why should engineers deny themselves the inspiration which the contemplation of the best thought of man affords? Why should engineers make of themselves calculating machines—automatons clad in khaki?" Why should they, indeed, with the field of literature that is open to them? What the retired engineer shall read in general literature is a problem that each individual must solve for himself. The domain is so vast that some discrimination is necessary. Unless he has depraved tastes, the best books for him may be those he likes best. At the same time reading what is truly literature is wiser than reading what is merely printed matter; it is better to be well acquainted with a few worth-while books than to have a superficial knowledge of a whole library.

Much has been written on the choice of reading matter. In mature years one does not want to read as a discipline. A theatrical manager occasionally put on performances of Shakespeare in order, he said, that people might appreciate his other productions, often of a low type. Relaxation from classical literature is sometimes sought in works of a lighter vein. This may partly account for the current flood of detective stories, many of them mere trash as far as literary merit is concerned.

On Earth, But in the Clouds.~Or, the retired engineer could enjoy the study of nature. The companionship of mountains and trees, of brooks and green fields, may be denied him, but the sky with all its phenomena is open even to the dweller in a city flat. Cloudland is a land of delight. A keen enjoyment is in store for all who have a sense of beauty and can really observe. Ruskin wrote on clouds and cloud beauty. Luke Howard (1772–1864), a member of the Society of Friends, wrote many books but is remembered best by his study and classification of the clouds (1802–1803). Upon it the present international classification of clouds is based. An observer can soon learn to distinguish the varying forms. Let him for a short time behold from his window the ever-changing picture which it frames.

If an acquaintance with the classification of clouds adds to the pleasure of the observer, a knowledge of the causes of their formation will add still more. Sky color, the glow of the rising and setting sun, the twilight arch, the glorious cloud fringes at the sunset hour, are beautiful beyond description. The keen observer will want to know their causes.

Benefits from Chess.~The pleasures of the retired engineer may be limited by two factors—his health and his finances. Travel and many amusements may be out of the question. The game of chess is recommended as specially adapted to him. The outlay of money required is trifling and the exertion is purely mental. If an opponent is not at hand he may train one, perhaps of his own household. An amateur and a seasoned player will each find it profitable to play over the games of the masters as recorded in books, studying any analysis or comments.

A knowledge of the history of the game, found in its extensive literature in many languages, adds enjoyment. One fragment will illustrate. The most famous "opening" is that of Ruy Lopez, a Spanish bishop, who in 1561 wrote a treatise on the game. For centuries the best defense to this opening has been disputed. Lopez denounced a defense that is popular today. Greco, in 1619, advocated a different opening. This was favored by the "illustrious Deschapelles" (1780–1847). The "immortal Philidor" in 1749 published his book. He advocated the defense that bears his name. The "Petroff" defense, named after a Russian player, is found in most, if not all, books on the game. The article "Chess" in the Encyclopaedia Britannica is of great value in studying openings, illustrative games, history, schools of play, and chess problems.

Maintaining Old Contacts.~The retired engineer should keep his friendships in repair. This requires time and effort. As he grows older associates are separated by distance and circumstance; some leave this life. A feeling of sadness often comes to him as they pass in review. New interests and new personalities must be found to take their places, even if they do not replace them in full. This is not treason to the old—they can still live in memory. Solemn thoughts need not always be sad thoughts. The engineer should have within him a fountain of perpetual youth.

But in cultivating worth-while friends, there are certain weaknesses against which the older man should guard himself. Undue fondness for reminiscing and telling the same story again and again may be mentioned. This failing does not come to the surface so frequently in writing. Correspondence may be made a delight rather than a bugbear. It should not be neglected. If with a fellow engineer, a solid technical element can be added to the spice of personalities. Letters should usually be answered, if any answer is demanded, soon after their receipt; an early reply increases its value.

"Last, the Best of All the Game."~In his technical activity, an engineer seldom becomes obsolescent. Rather his value improves with age. Oddly enough he is often retired at the most productive period of his mental development. As he turns perforce to other activities, he may well anticipate a renewed usefulness and an increasing satisfaction in life. Then truly he may prove the validity of Robert Browning's immortal lines:

"The best is yet to be,
The last of life, for which the first was made."

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NUMBER 2

The Pennsylvania Turnpike

Interesting Features of the Longest Toll Superhighway in the United States

FROM A PAPER BEFORE THE METROPOLITAN SECTION

By HERSCHEL H. ALLEN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

MEMBER OF THE FIRM OF J. E. GREINER COMPANY, BALTIMORE, MD.

ONE hundred and sixty miles without a stop, and at a speed of one's own choosing, is the prospect on the superhighway now being pushed to completion between Harrisburg and Pittsburgh. Mr. Allen here reviews briefly the history of the project, and describes its outstanding features—the tunnels, the interchanges, the limiting grades and curves. An account of the construction methods is reserved for a later issue.

THE Pennsylvania Turnpike—longest toll superhighway in the United States—is scheduled for completion in June 1940. Extending from a point about 16 miles west of Harrisburg to about 20 miles east of Pittsburgh, it will provide a 160-mile stretch over which motor vehicles can travel without a single stop, and at a speed limited essentially only by their performance qualifications. There will be not a single left turn in the entire distance, nor a single grade crossing, and even the heaviest modern trucks will be able to travel the full length of the Pennsylvania Turnpike without having to shift gears.

Less than three years ago the surveys indicating the feasibility of the project were completed, and in May 1937 the Pennsylvania Legislature passed an act creating the Pennsylvania Turnpike Commission and empowering it to finance, construct, and operate the road. The first construction contract was awarded in October of the following year, and by the end of 1939 grading and drainage structure contracts had been let for the entire job.

The original intention was for the turnpike to follow the partially graded line and the partially excavated tunnels of the old South Penn Railroad, the construction of which was started in the early 1880's and finally abandoned about 1885. As finally laid out, the turnpike route does include six of the old tunnels, but follows the railroad right of way for a total distance of only about 34 miles. Between tunnel portals it has been possible, in general, to improve on the old alinement by the use of 3% maximum grades in place of the 2% grades controlling the earlier location.

WITHIN THE PORTAL OF EAST KITTATINNY MOUNTAIN TUNNEL

Across the Narrow Valley Is the West Portal of Blue Mountain Tunnel

Employment of engineers to prepare traffic surveys and traffic reports for use in financing the turnpike was among the first steps to be taken by the commission. These reports, completed in due course, included estimates of gross revenue from tolls for the first ten years of operation. The average estimated gross revenue during this period amounts to \$4,117,000 annually, beginning at \$2,670,000 for the first full year and reaching \$4,832,000 during the tenth year of operation. These estimates are based upon tolls per trip amounting to \$1.50 for passenger automobiles and a graduated scale of rates ranging from \$3.00 to \$10.00 for trucks, semi-trailers, and full trailers. Partial trips are based on approximately 1 cent per mile for an automobile and from 2 to 8 cents per mile for trucks and trailers, depending upon size.

The next move of the commission was the employment of engineers to prepare an engineering report and estimates of cost of the entire project. The commission then undertook preliminary negotiations for financing the project, which finally resulted in success on October 10, 1938, when an agreement between the Public Works Administration and the commission for a grant of \$26,100,000 was executed. This agreement was based upon the completion of the entire project by May 1, 1940 (afterwards extended to June 29 of the same year). On October 10, 1938, the commission also concluded negotiations

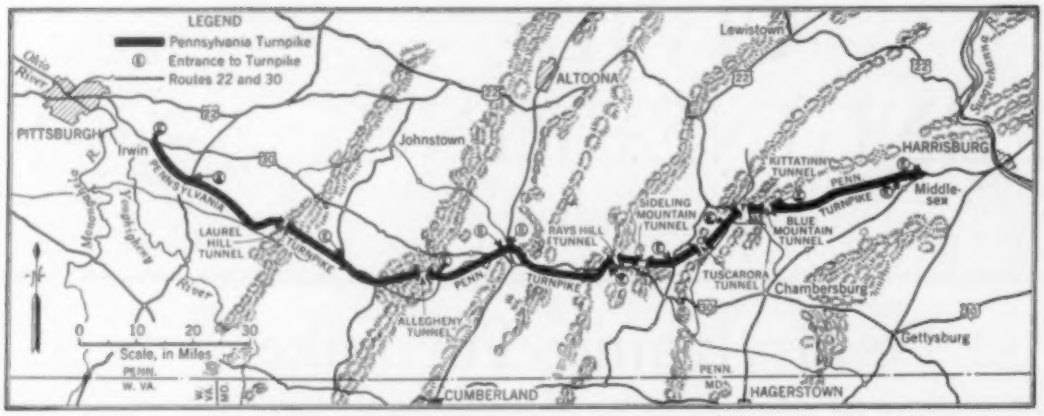


FIG. 1. THE PENNSYLVANIA TURNPIKE, SHOWING INTERCHANGES (ENTRANCES) AND TUNNELS

with the Reconstruction Finance Corporation for the sale of \$35,000,000 of Commonwealth of Pennsylvania Turnpike revenue bonds. The funds made available under the terms of the grant agreement and bond sale are placed in the construction fund, secured by a trust indenture between the commission and the trustee.

Up to January 15, 1940, the Reconstruction Finance Corporation had taken up \$20,000,000 of the turnpike bonds in two installments of \$10,000,000 each, and the Public Works Administration had delivered \$6,000,000 cash to the trustee, with an additional \$6,000,000 in the course of delivery. The sale of bonds in installments, as needed by the commission, has had the effect of reducing interest during construction to a minimum.

TUNNELS ELIMINATE TWO MILES OF VERTICAL CLIMB

The route of the turnpike is shown in Fig. 1. Its eastern terminus, at Middlesex, is connected by an interchange with U.S. Route No. 11, sixteen miles west of Harrisburg. Its western terminus, at Irwin, connects by an interchange with U.S. Route No. 30, twenty miles east of Pittsburgh. There are seven tunnels along the route, six of which, as previously mentioned, had been partially constructed by the South Penn Railroad more than fifty years ago.

The road ascends from 400 ft above sea level, in the Susquehanna River Valley at the eastern terminus, to nearly 2,500 ft at the floor of the Laurel Hill tunnel, and then gradually descends to 1,000 ft at the western terminus. The significance of these figures can be better appreciated when it is understood that the total accumulated vertical climb from Middlesex to Irwin on the turnpike is less than 4,000 ft, whereas by way of existing U.S. Routes Nos. 11 and 30 it is 13,000 ft, or a difference of almost two miles of vertical climb. The maximum 3% grades on the new route will give the motorist very little sensation of either climbing or descending. Moreover, with the tunnels from 350 to 900 ft below the crest of the mountains, it will be possible to drive along the turnpike in relatively clear weather when the highways over the mountains will be shrouded in fog.

In general the right of way is 200 ft in width, with extra width provided at interchanges and tunnel portals, and at other points where additional property is required for maintenance operations. About 750 parcels of property make up the complete 160 miles of right of way. It is of interest to note that the laws of Pennsylvania governing eminent domain make provision for the commission to post bonds for property required for turnpike purposes, the amount of the bond to be fixed by the local court if it has not previously been agreed to by the commission and the property owner. Upon the posting of a bond, the commission is then at liberty to enter upon the premises, even though the final settlement for the right of way may not at that time have been concluded. This provision of Pennsylvania law, which is different from that in many other states, explains why it was possible, in the short time available, to acquire such a large number of parcels of property for right-of-way purposes.

The roadway has been designed for safety at high speeds. It is graded for a width of 78 ft, which provides a medial strip 10 ft wide, two 24-ft concrete traffic lanes, and two 10-ft shoulders. Horizontal curves vary up to a maximum of 6°, with the sharpest curves restricted to a relatively short stretch east of Alleghany Mountain. In the rolling terrain in Cumberland County, for 28 miles from the eastern terminus to Blue Mountain, the alinement is quite straight with only two flat curves. The alinement is also straight through many of the intervening valleys.

With few exceptions, the structures on the turnpike have been included in the contracts for grading. There are 300 bridges, of which 140 are drainage structures and 160 are grade-separation structures. Of the latter, 80 are overhead crossings carrying two-lane roadways; 60 are underpasses, which consist of bridges carrying the turnpike across other highways; and the remaining 20 bridges carry the turnpike across interchange connections, railroads, trolley lines, and private driveways or roadways. When it is considered that practically all these structures required individual study and design, the high pressure under which the engineering work has been executed can be readily appreciated. Only two bridges were designed by other than the commission's engineers.

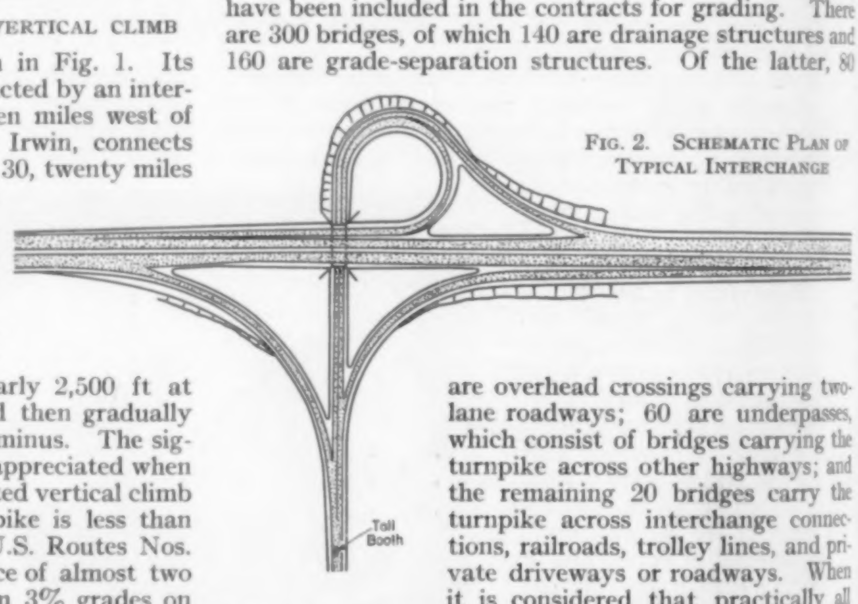
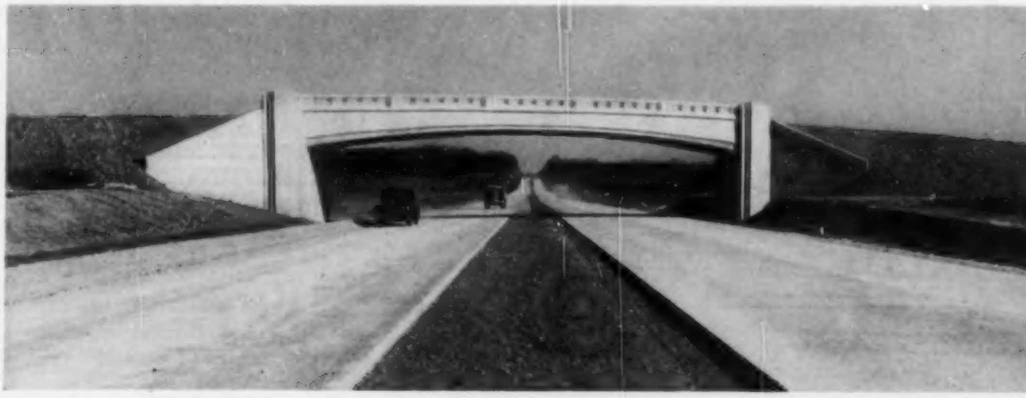


FIG. 2. SCHEMATIC PLAN OF TYPICAL INTERCHANGE

PROVISIONS FOR ENTRANCE AND EXIT

Motor vehicles may leave or enter the turnpike at predetermined points only. Interchanges are provided at each terminus, and at eight intermediate points (Fig. 1) where the turnpike intersects the principal traffic routes of the Pennsylvania highway system and where the induced traffic has been estimated as sufficient to pay for the construction and operation of the interchange. The greatest distance between interchanges is 36 miles between Bedford and Somerset.

Figure 2 is a schematic layout of a typical intermediate interchange, designed to safely accommodate traffic on and off the turnpike without interference with the through traffic on the turnpike. In order to reduce operating personnel to a minimum, the toll booth is designed for one-man operation, and is located between the on-going and the off-going lanes, so that traffic in both directions pays toll at the same booth.



A Preview of the Turnpike—Partially Completed Pavement and Reinforced Concrete Rigid-Frame Overpass

A decelerating lane and an accelerating lane lead off and on to the turnpike in each direction. These lanes are parallel and adjacent to the outside lanes of the turnpike, and are from 1,000 to 1,200 ft long, allowing traffic to pull off to the right and decelerate before making the turn to slow down at toll plazas for paying tolls or checking in before entering the adjacent state highway route. In entering, a vehicle approaches the turnpike on a curve leading into the accelerating lane, which allows the motorist to enter the right-hand lane of the turnpike in the direction in which he is traveling after accelerating to the necessary speed in a distance of 1,000 to 1,200 ft. Each of the interchanges includes an overhead crossing or underpass to allow traffic from the opposite side to cross the turnpike and pass the toll booth without interfering in any way with the through lanes of the turnpike.

During the fifty years that have elapsed since the South Penn Railroad abandoned construction operations, the portals to the old tunnels had become almost obliterated by trees and vegetation, and fully or partially closed by erosion and sloughing. In the case of the west portal to the Rays Hill tunnel the opening had been entirely closed, and its location was found only by following the faintly discernible approach cut.

About half the total tunnel length had previously been partially excavated. Those portions that had been opened for double tracks required very little widening. However, those excavated for a single track only at the time the work was abandoned, required widening to provide for the 28-ft 6-in. clear width between concrete side walls necessary to accommodate the roadway and sidewalk.

The total length of the seven tunnels is slightly less than seven miles. As will be noted in Fig. 3, the roadway in the tunnels is 23 ft wide between curbs, accommodating two $11^1/_2$-ft traffic lanes. All the remaining 153 miles of turnpike provide for two lanes of traffic in each direction. The decision of the commission to use single tubes providing for only one lane in each direction at each of the tunnel locations was reached after considering the factors of traffic, gross revenues from tolls, capacity of tunnels, and cost of additional tubes. The studies indicated that there is likely to be insufficient traffic during the first years of operation to warrant the expenditure of an additional 12 to 15 million dollars to construct an additional tube at each tunnel location; that the capacity of the tunnels as now being built greatly exceeds the estimated traffic for the tenth year of operation; and that it will be possible in the future to add an additional tube at each location long before this betterment is needed from the standpoint of traffic congestion, because the increased revenues would then be more than ample to cover the additional cost.

In addition to the roadway, each tunnel accommodates a narrow sidewalk for maintenance and patrolling purposes (Fig. 3). The normal lining thickness for side walls and arch is 18 in. The concrete, in general, will be placed against the rock. Where weak strata occur, the rock walls and roof are being supported by steel arch ribs or timber sets, the size and spacing of which is determined in the field.

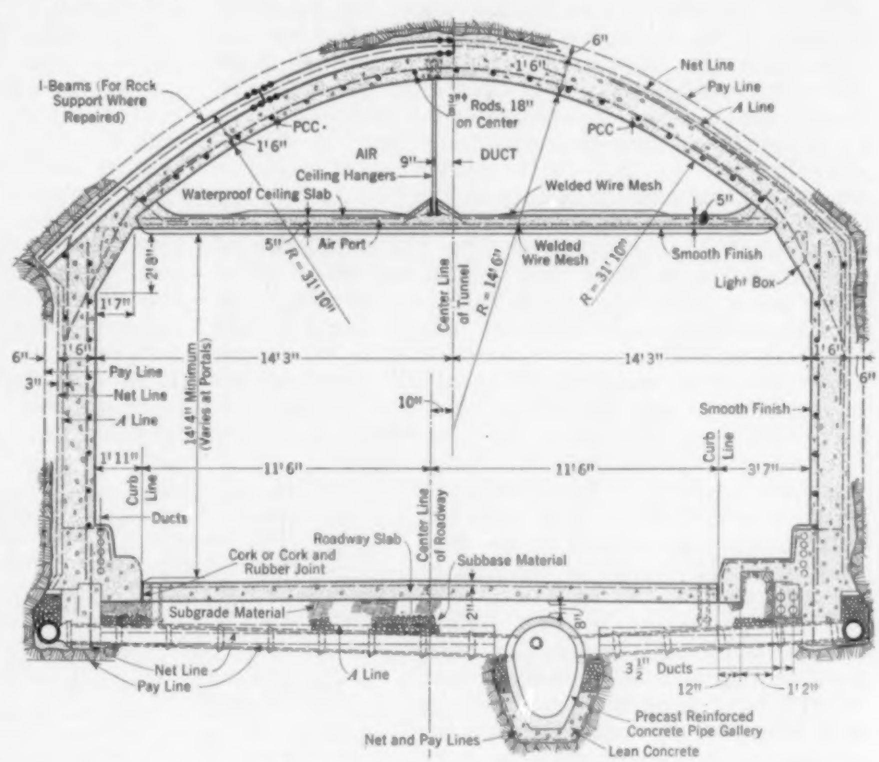


Fig. 3. Typical Tunnel Section

TUSCARORA TUNNEL—ONE OF THE SIX FIFTY-YEAR-OLD RAILROAD TUNNELS NOW BEING REVAMPED FOR TURNPIKE USE

All tunnels will be ventilated by electrically driven fans, located in buildings at the portals. The space between the tunnel-lining arch and the suspended roadway ceiling slab forms the ventilation duct, from which fresh air will be discharged into the main roadway section through regularly spaced portholes. The tunnels will be lighted continuously by a series system of mercury vapor lights in the ceiling. An emergency gasoline-electric incandescent lighting system will also be provided.

SUPERELEVATION AND TRANSITIONS

Typical turnpike cross-sections on tangents and superelevated curves are shown in Fig. 4. The normal cross section on tangents provides a drainage crown of 3 in. in the medial strip, a cross slope of 3 in. in each of the 24-ft concrete lanes, and sufficient slope on the shoulders, both in cuts and fills, for adequate drainage. Curves of 0° 30′ and sharper are superelevated, and those of 2° 30′ and sharper, are provided with transitions. Cross slopes on superelevated curves vary from 1% to a maximum of 10%, the latter being equivalent to about $1^3/_{16}$ in. per ft of width. The decision to use transitions was reached after exhaustive studies had indicated that high-speed operation would be safer with them than without, even though the 12-ft traffic lanes provided sufficient width for motorists to "drive their own transitions" in negotiating the flatter curves. On the sharper curves, of course, use of transitions was necessary in any case to ease the change from normal cross slope to superelevation.

The total excavation required for the completion of the turnpike amounts to more than 25,500,000 cu yd, of which about 750,000 cu yd is in tunnel. The biggest cut is at Clear Ridge (near Bedford)—a half mile long and 153 ft deep, with a total volume of 1,150,000 cu yd. Three other cuts exceed 300,000 cu yd each, and there are several more of over 200,000 cu yd. The heaviest embankments vary from 75 to 90 ft in height above the original surface of the ground. As for materials, a total of 1,617,000 cu yd of concrete and 45,600 tons of steel will be required. About 15,000 men were at work on the project at the peak of operations.

The organization of the various administrative and engineering units is noteworthy because of the short time allowed for setting them up, and the large personnel required to perform the administrative and engineering work for this project in the limited construction period. The fact that contractors are working night and day also makes necessary more engineering supervision personnel than would otherwise be required.

Five members make up the commission, which is headed by Walter A. Jones as chairman, with John D. Faller as secretary-treasurer and general counsel. The administrative group includes units for legal and right-of-way work, auditing, purchasing, publicity, and general service.

THE ENGINEERING ORGANIZATION

The engineering organization is composed of five principal divisions—highway, tunnels, bridges, architectural, and electrical—and is headed by Chief Engineer Samuel W. Marshall. Charles M. Noble, M. Am. Soc. C.E., is special highway engineer; Roger B. Stone, chief construction engineer; Fred S. Poorman, assistant chief engineer; Richard M. Merriman, M. Am. Soc. C.E., chief engineer of tunnels; Richard Graef, chief of bridges; and Gerald Tyler, in charge of the architectural work.

GRADING OPERATIONS ON A CURVE IN RUGGED WESTMORELAND COUNTY

The Public Works Administration is represented by James F. Murphy, Assoc. M. Am. Soc. C.E., project engineer; the Reconstruction Finance Corporation by Col. F. E. Lamphere, M. Am. Soc. C.E., inspecting engineer; and the State Highway Department by I. Lamont Hughes, secretary of highways and ex officio member of the commission.

Engineering contracts for the design of two bridges have been awarded to the firms of Parsons, Klapp, Brinckerhoff and Douglas, of New York, and Modjeski and Masters of Harrisburg. Special consultants include Ralph Smillie, M. Am. Soc. C.E., on tunnels; Charles M. Upham, M. Am. Soc. C.E., on special highway matters; and Arthur J. Sweet, on lighting. J. E. Greiner Company, of Baltimore and Harrisburg, are consulting engineers under the trust indenture securing the construction funds.

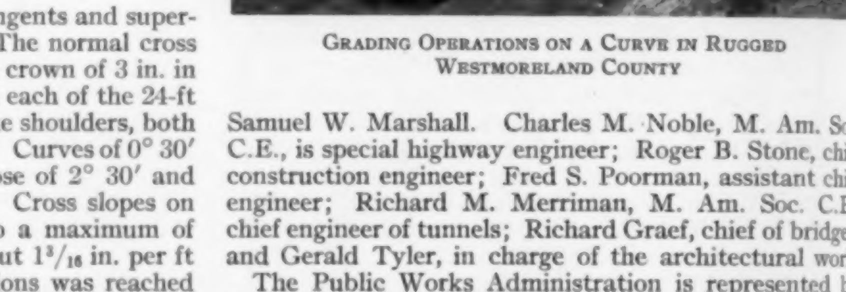


FIG. 4. PAVEMENT SECTIONS ON TANGENT (ABOVE) AND SUPERELEVATED CURVES (BELOW)

Effect of Connections and Rivet Holes on Ductility and Strength of Steel Angles

By J. A. Van den Broek

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In February 1939, Professor Van den Broek presented in the Society's "Proceedings" the "Theory of Limit Design." The present article reports a series of tests on bar-size angles, conceived in the light of that theory and designed to show how certain properties of members composed of such angles can be improved. Specifically, the tests indicate that by making suitable end connections and perforating the legs of the angle with extra holes, the ductility of the member may be increased, and the weight decreased, without sacrifice of strength. No claim to conclusions of immediate practical value is made, but the reasoning underlying these tests, and the possible results of further research along similar lines, are worthy of consideration. This paper was originally presented before the American Institute of Steel Construction at its annual meeting in New York, N.Y., in October 1939.

Punching holes in the ends of tension members, in order to provide for connections, not only lessens the strength of these members but may seriously impair their ductility as a whole. In the series of tests on small angles described here, the effects of various types of end connection on strength and ductility were investigated, and it was further shown that by perforating the legs of the angle with extra holes the ductility of the member might be increased and the weight reduced without sacrifice of strength.

These tests, carried out by the writer at the University of Michigan, were of very limited range, having been confined entirely to $1\frac{3}{4}$ by $1\frac{3}{4}$ by $\frac{1}{8}$-in. angles. They may be regarded as fairly comprehensive, however, if considered in connection with the design of cross-bracing in transmission line and radio towers, or of aeroplane bracing. Moreover, the theory of "limit design" that gave rise to these tests, and the conclusions drawn from them, appear more or less applicable to all redundant structures built of ductile materials.

Only one record was obtained for each different type of test specimen. However, the fact that 36 specimens were tested, all with the same physical properties and all of the same length, should go far toward giving the conclusions based thereon a general application. All specimens were obtained through the Carnegie-Illinois Steel Corporation, were manufactured to A.S.T.M. Specification A-7-36, and were rolled from the same billet. The yield-point strength of the material was 42,800 lb per sq in.; its ultimate strength, 68,400 lb per sq in.; and its elongation in 8 in., 21.9%. All of the 20 tension specimens were pulled by means of two $\frac{5}{8}$-in. bolts in $\frac{11}{16}$-in. holes at each end, and all of the 16 compression specimens were loaded through one $\frac{5}{8}$-in. bolt in an $\frac{11}{16}$-in. hole at each end. The outer holes in all tensile specimens, and the holes through which loading was applied to the compressive specimens, were 70 in. from center to center. All bolts were drawn up by the same man and tightened to approximately the same degree. Owing to lack of proper punching equipment, all holes were drilled. The gage line in all specimens was 1 in. from back of angle, and as the minimum radius of gyration was affected but little by the extra holes, the l/r of all compression specimens was practically constant and equal to 200.

The test specimens are classified into six series—A, B, C, D, E, and F—with individual specimens in each series indicated by subscripts. All uneven subscripts refer to tension tests, and all even subscripts to compression tests. Series A (Fig. 1) represents the connection detail most commonly used in present practice; the specimens differ from each other in the number of extra holes punched in the leg of the angle containing the bolt holes. Series B

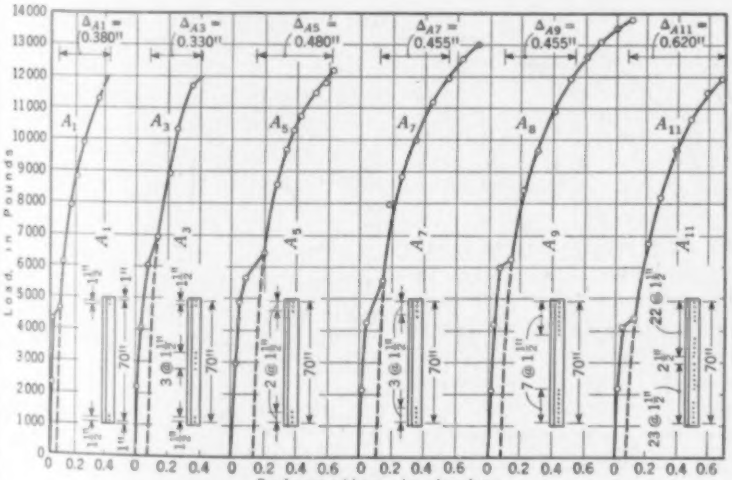

Fig. 1. Load-Deformation Curves for Tension Specimens of Angles of Series A

Connections Through One Leg, Unmodified; Perforations in One Leg

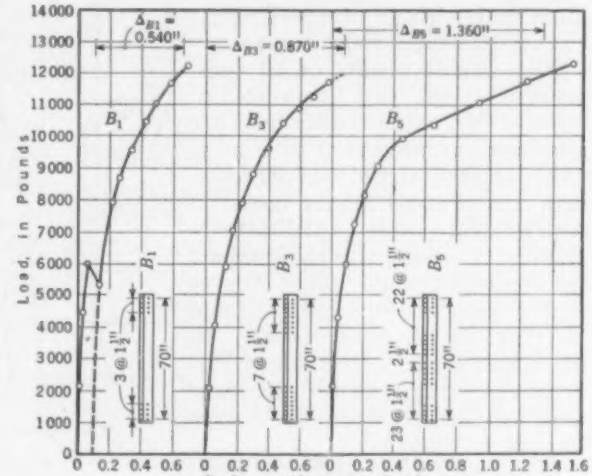

Fig. 2. Load-Deformation Curves for Tension Specimens of Angles of Series B

Connections Through One Leg, Unmodified, Perforations in Both Legs

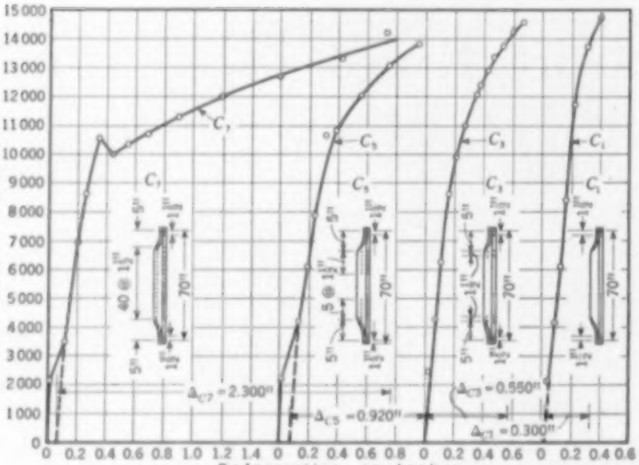

FIG. 3. LOAD-DEFORMATION CURVES FOR TENSION SPECIMENS OF ANGLES OF SERIES C

One Leg at Each End Bent Through 90° and Flattened on Other Leg; Perforations in Both Legs

(Fig. 2) represents angles loaded in the same way as those in series A, but with extra holes drilled in both legs. The purpose of the extra holes is to distribute the yielding through a portion of the specimen or throughout its entire length instead of localizing it around the bolt hole. The holes are therefore purposely placed in line, instead of being staggered. In series C (Fig. 3) the end connections of all specimens are formed by bending one leg of the angle through 90° until it lies flat upon the other leg. The extra holes in both legs are similar to those in series B and are not staggered. Specimens of series D (Fig. 4) have both legs bent outward at the ends, through an angle of 45°, so that they are brought into one plane. The extra holes in the legs of these specimens are staggered. In series E and series F (Figs. 5 and 6) the end connections of all specimens are formed by folding both legs of the angle in through 45°, so that they lie flat on one another. Series E consists of a single specimen, tested while gripped between the wedges of the machine instead of being tested through the medium of bolts. Specimens F_1 and F_2 contain no extra holes, while specimens F_3 and F_4 contain holes in both legs (not staggered) throughout their entire length.

The salient results of all compression tests are recorded in Table I, while the tensile tests are graphically represented by Figs. 1 to 6. In general, the load deformation curves of all angles tested in compression were qualitatively similar. Nothing was to be gained by reproducing all these curves and so only the one for specimen A_6 (Fig. 7) has been shown. In the insert near the left side of Fig. 7 this curve is drawn to the same scale as that used for the curves in Figs. 1 through 5.

Effect of Extra Holes on Compressive Strength. An estimate of the effect of extra holes on the compressive strength of angles is obtained by comparing the values in Col. 3, Table I, within each series. It appears that angle C_8, with 82 extra holes, had a compressive strength of 3,360 lb, or 18% less than C_2, which had no extra holes. Angle B_6 with 86 extra holes, on the other hand, had a compressive strength of 4,850 lb, or an increase of 14% over the strength of B_2, which had no extra holes. The variation in the strength of specimens within each series is no greater than the possible variation in strength beween compression tests on identical specimens. This leads to the conclusion that the presence of extra holes in angles affects their compressive strength very little.

TABLE I. COMPRESSION TESTS OF $1^3/_4$ BY $1^3/_4$ BY $^1/_8$-IN. ANGLES

All Angles Were Loaded Through One $^5/_8$-In. Bolt at Each End Spaced 70 In. Center to Center. All Holes Were $^{11}/_{16}$ In.

SPECIMEN	NUMBER OF EXTRA HOLES	CAPACITY LOAD IN LB	BUCKLED ABOUT AXIS MARKED...	LOAD CORRESPONDING TO DEFORMATION OF 0.400 IN.
A_2	0	4,080	∟	2,180
A_4	4*	3,970	∟	2,080
A_6	2*	4,100	∟	2,150
A_8	4*	4,330	∟	2,300
A_{10}	12*	4,110	∟	2,280
A_{11}	43*	3,660	∟	2,140
B_2	8†	4,230	∟	2,300
B_4	24†	3,880	∟	2,450
B_6	86†	4,850	∟	2,450
C_2	0	3,970	∟	1,880
C_4	8†	4,020	∟	2,170
C_6	24†	3,780	∟	1,990
C_8	82†	3,360	∟	1,320
D_2	0	2,360	∟	1,830
F_2	0	5,150	∟	1,820
F_4	82†	5,280	∟	1,870

* Extra holes in one leg only. †Extra holes in both legs.

This conclusion is not as paradoxical as it may appear at first glance. The extra holes do reduce the cross-sectional area in the region where buckling takes place and likewise reduce the moments of inertia about axes parallel to the legs. But the minimum moment of inertia (the moment about the Z-Z axis) is reduced but little, as the holes are located directly on that axis. Hence the buckling strength is not materially affected.

Effect of Connection on Compressive Strength. An estimate of the effect the different types of connections have on the compressive strength of the angles is obtained by comparing the different series one to another (Col. 3, Table I). It appears that the compressive strength of angles is influenced very largely by the eccentricity of the applied load. Specimen D_2, with flattened ends (same as D_1, illustrated in Fig. 4), was the most eccentrically loaded with reference to the centroid of the section midway between the ends, and carried the smallest load (2,360 lb), while specimens in series F, with ends folded in and almost concentrically loaded (see Fig. 5 for type), registered the greatest strength (5,200 lb). Specimens in series A, B, and C, that had loads applied with approximately the same eccentricity, registered about the same compressive strength, averaging 4,000 lb.

In connection with the tension tests, no heed was given to the

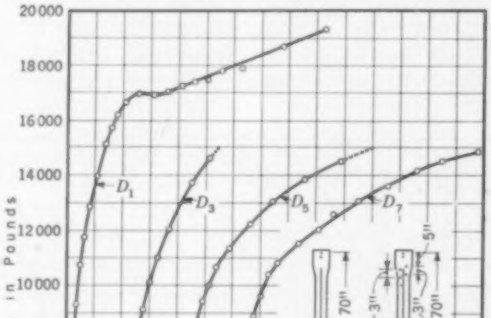

FIG. 4. LOAD-DEFORMATION CURVES FOR TENSION SPECIMENS OF ANGLES OF SERIES D

Both Legs, at Each End, Bent Out Through 45° to Form a Flat Surface; Perforations in Both Legs

slack due to the difference in diameter between the bolts and the bolt holes. Since the bolts were $^5/_8$ in. in diameter and the holes $^{11}/_{16}$ in. (which is standard in transmission-line building practice), there was a possible play of $^2/_{16}$ in. As indicated in the diagrams —notably Figs. 1, 2, and 3—slip occurred when the load was increased to a magnitude ranging between 4,000 and 6,000 lb. Curve B_1 (Fig. 2) strikingly shows the effect of this slip. It is noted that the total slip in no case exceeds $^1/_8$ in., which is the total play in the holes at both ends of a specimen. In the compression tests the play in the holes was carefully taken up before beginning the tests.

Effect of Connection on Tensile Strength. To estimate the effect of end-fastening on the tensile strength of the angles, the different strength values of specimens A_1, C_1, D_1, E_1, and F_1 are to be compared (see the curves corresponding to these particular specimens in Figs. 1, 3, 4, 6, and 5, respectively). The subscript 1 indicates that these specimens did not contain any holes other than those necessary for the bolts through which the load was applied. Specimen E_1 registered the greatest tensile strength (24,800 lb). However, this result is only of academic interest, since specimen E_1 was centrally loaded and tested while held between wedges in the testing machine. The weakest of the angles was specimen A_1 (11,800 lb), bolted through one leg. Specimen D_1 registered a material increase in strength (19,340 lb) over specimen A_1. This increase is explained by the fact that D_1 was centrally loaded, while A_1 was loaded with a large eccentricity that developed severe stress concentration around the bolt hole.

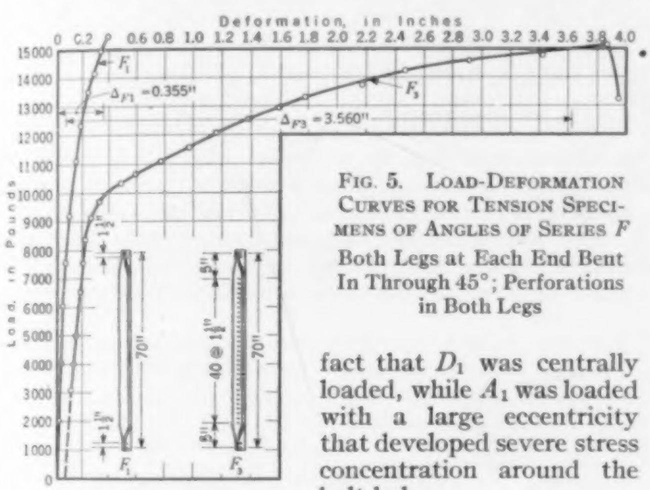

FIG. 5. LOAD-DEFORMATION CURVES FOR TENSION SPECIMENS OF ANGLES OF SERIES *F*
Both Legs at Each End Bent In Through 45°; Perforations in Both Legs

(In an earlier paragraph the inferior compressive strength of specimen D_2 was attributed to the eccentricity of the loading, while at this point the superior tensile strength of specimen D_1 is ascribed to its lack of eccentricity. This is not inconsistent as may appear at first glance. When tested in compression the angle buckles; the failure takes place halfway between the bolts through which the load is applied, and the eccentricity relative to the section at that point is the governing factor. When tested in tension the failure takes place through the bolt hole and the eccentricity or lack of eccentricity in the placement of the bolt hole is the determining factor. This explains how the same specimen may be said to be nearly concentrically loaded in tension and quite eccentrically loaded in compression.)

In specimens C_1 and F_1 the legs of the angle irons are folded at their ends, and two thicknesses of metal are punched out instead of one. This accounts for their strengths (15,400 lb for C_1 and 16,450 lb for F_1) being less than that of specimen D_1. However, the strength of both C_1 (15,400 lb) and F_1 (16,450 lb) was greater than that of A_1, because of their lesser eccentricity and lesser stress

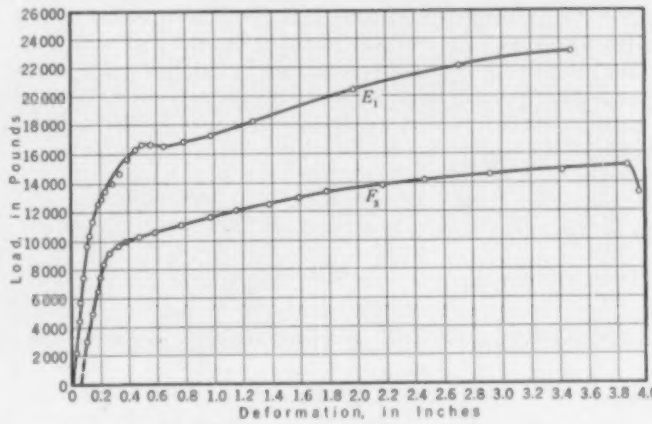

FIG. 6. LOAD-DEFORMATION CURVE FOR TENSION TEST OF SPECIMEN E_1, WITH CURVE OF F_3 FOR COMPARISON
These Curves Are Drawn to About Half the Vertical Scale of Figs. 1 Through 5

concentration around the bolt holes. Comparing specimens F_1 and C_1, the former's greater strength appears due to the fact that it is more concentrically loaded.

Effect of Extra Holes on Tensile Strength. To arrive at an estimate of the effect of the extra holes on the tensile strength of the angles, the values for specimens within each series are to be compared (Figs. 1 through 5). In some of the series (C, D, and F) the specimens with additional holes registered less strength than those having no extra holes, while in other series (A and B) they registered more. The difference in each case was no greater than what might be found in a test of two identical specimens. The conclusion, therefore, is that extra holes in angles (with certain exceptions) do not greatly affect the tensile strength. In series D, specimen D_1 without any extra holes, registered a decidedly greater tensile strength than did the others containing extra holes. This result was wholly anticipated. In series D, which did not have unfavorable stress concentration around the bolt hole, the extra holes were staggered so that the net cross section would not be reduced beyond that already effected by the bolt holes. The extra holes in the legs (D_3, D_5, D_7) created an eccentricity and an unfavorable stress concentration around the extra holes which was absent in specimen D_1.

Effect of Extra Holes on Ductility. The extra holes were introduced for the purpose of distributing the yielding throughout the member, instead of localizing it around the bolt hole. An estimate of the effect of the extra holes on the ductility of the angles is obtained by a study of the graphs shown in Figs. 1 through 6. All graphs represent load-deformation curves of angles of the same length. The offset that appears on some of these graphs registers the slip of the bolts in the bolt holes.

In series A (Fig. 1) the deformation does not seem to be greatly affected by the presence of extra holes in one leg of the iron. This, it should be stated, was as anticipated. In both series A and series B, the member is weakened not only by the bolt hole but by the very unfavorable stress concentration resulting from its eccentric location; thus it was not to be expected that extra holes in only one leg (as in series A) would show the desired result.

Series B (Fig. 2) was planned with holes in both legs, holes punched in line (not staggered). This was done to produce a weakening sufficient to insure ductile yielding in the body of the member before the angle broke through the bolt hole. It appears that, in comparison with specimen A_1, all curves in series B show essentially the

same strength, and indicate that the ductility increased in proportion to the number of extra holes.

Series C (Fig. 3) and series F (Fig. 5) show the same qualitative results as series B (Fig. 2). The ductility of the member increased with the number of extra holes without the ultimate strength being seriously affected.

Series D (Fig. 4) appears to show results contrary to the general trend. Within series D, specimen D_1, with no extra holes, shows both greater strength and greater

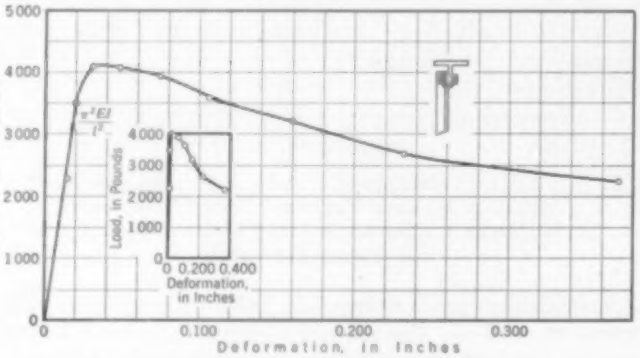

FIG. 7. LOAD-DEFORMATION CURVE FOR COMPRESSION TEST ON SPECIMEN A_6
Plotting in the Small Insert Is to Same Scale as Figs. 1 Through 5

ductility. However, in series D the bolt hole was placed on the axis of symmetry, thus reducing the eccentricity as well as the stress concentration to a very small value. Furthermore, only one metal thickness was affected by the punching of the bolt hole. As a result, the member as a whole was able to yield beyond the elastic limit before rupture through the bolt hole could occur. The weakness of specimens D_3, D_5, and D_7 was due to the eccentricity introduced by the extra staggered holes, which was not present in specimen D_1.

As to the merits of the various types of specimens studied, a variety of conclusions may be reached, depending in each case on the function which the angle is called upon to perform. Angles of the type tested in series D are undesirable for cross-bracing purposes. When they are used for cross bracing, a connection at the points where they cross can be effected only when the angles are cut and assembled again by means of a gusset plate. Angles of type F can be used for cross bracing if they are crimped at the points where they cross, in a manner similar to that in which they are crimped at the ends. For purposes of cross bracing, without the necessity of using gusset plates or of extra crimping, angles of types A and B should be compared with angles of type C. For cross bracing in aeroplane construction, angles of types B_5 and C_7 are superior to the common type represented by A_1. Their superiority lies, in each case, in the fact that the member has less weight but equal or superior strength. B_5 is equal to A_1 in compression and tension, and C_7 is equal to A_1 in compression and superior in tension. (See Table II.)

For single bracing, angles of the type represented by series F are superior from every viewpoint. The ends may be shaped at low cost. The two legs of the angle may simply be pressed together cold, if provision is made for keeping the ends in alinement with the axis of the member. Specimen F_3 shows an increase in tensile strength of $\frac{15{,}200 - 11{,}800}{11{,}800} = 29\%$ over specimen A_1; an increase in compressive strength of $\frac{5{,}280 - 4{,}080}{4{,}080} = 29\%$; an increase in ductility of $\frac{3.800 - 0.3675}{0.3675} = 930\%$; and a decrease in weight of $1.00 - \frac{0.63 - 0.0928}{0.63} = 15\%$. (The percentage decrease in weight is the same as the percentage decrease in volume. The figure 0.63 represents the volume of a specimen for each $1^1/_2$ in. in length with no holes punched out. The figure 0.0928 represents the volume of two holes, $^{11}/_{16}$ in. in diameter, cut out in each $1^1/_2$ in. of length.)

Table II lists the tensile and compressive "strength efficiency" per unit of weight and the "ductility efficiency" per unit of length. In all cases specimens A_1 and A_2, representing the detail in most common use, were taken as a standard of comparison.

The coefficients in Table II were obtained in the following manner: The volume of an unperforated specimen is 1.26 in.^{3} in 3 in. of length. The strength of specimen A_1 is 11,800 lb. In computing the tensile strength efficiency per unit of weight, then, the ratio of $\frac{11{,}800}{1.26} =$ 9,360 becomes the standard of comparison. The volume of specimen F_3 for each 3 in. of length is 1.0744 (the same as that for A_1, minus the volume of four holes). The ratio of strength to volume, in case of specimen F_3, thus becomes $\frac{15{,}200}{1.0744} = 14{,}150$, and the tensile strength efficiency per unit of weight for specimen F_3 is $\frac{14{,}150}{9{,}360} = 151$– a 51% increase over specimen A_1. Since F_1 and A_1 have the same volume, the strength efficiency per unit of weight for specimen F_1 is $\frac{16{,}450}{11{,}800} = 139$. From Table II, in case of cross bracing, it appears that specimens C_7 and C_8 register the highest efficiency, while, for single bracing, specimens F_3 and F_4 appear to be the most efficient.

The tests discussed in this paper are of a qualitative nature. They point to a possible gain in efficiency in point of strength, ductility, and weight, by means of a suitable selection of end connection and of extra holes in the angle legs. It seems reasonable to anticipate similar and even more pronounced effects from the use of smaller angles, say, $1^1/_2$ by $1^1/_2$ in. by $^1/_8$ in., with $^{11}/_{16}$-in. holes. In larger angles, with the same size holes, eccentricity and stress concentration would be relatively less, and the beneficial effects from extra holes in the angle legs would be less pronounced. In sufficiently large angles the yield point in the body of the member might be passed before rupture through the bolt hole would occur. In such case also, extra holes in the angle leg might increase its ductility, but not to the same degree as that shown in these tests.

In single diagonal bracing it might be desirable to employ members in which the compression strength and tension strength are equal. In that case, angle irons with a slenderness ratio of $l/r = 83$ would be indicated. Tests on angles similar to the ones here discussed, but with slenderness ratios in the range of 80 to 200, would appear very desirable in this connection.

TABLE II. COMPARATIVE STRENGTH EFFICIENCIES AND DUCTILITY EFFICIENCIES OF VARIOUS SPECIMENS

TENSION SPECIMENS	A_1	B_5	C_1	C_7	D_1	D_7	F_1	F
Tensile-strength efficiency per unit of weight	100	128	130	141	164	136	139	151
Ductility efficiency per unit of length	100	415	180	630	505	480	190	1,0[illegible]
COMPRESSION SPECIMENS	A_2	B_6	C_2	C_8 . D_2		—	F_2	F
Compressive-strength efficiency per unit of weight	100	139	97	96	58	—	126	[illegible]

Construction Sequence in

The Wailuku River Bridge, Hawaii

Attractive Arch Span Replaces Old, Ungainly Truss

By Harry A. Ciufi

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Of interest in both design and construction is the 168-ft concrete arch bridge across the Wailuku River at Hilo, Hawaii. Though the roadway is suspended from the arch for the greater part of the span, the hangers are not steel sections embedded in concrete, as one might assume, but typical reinforced concrete members. Timber falsework trusses of 140-ft span were used in construction, and as a consequence the deflections of the forms during pouring required particular attention. Preloading the roadway forms with pig iron ballast provided a satisfactory solution of the problem.

An unusually attractive concrete bridge in the shape of a rainbow arch, recently constructed across the Wailuku River in Hilo, Hawaii, fully achieves the designer's aim of preserving the natural beauty of the setting without sacrifice of economy. The bridge is located 1,000 ft from the point where the river empties into Hilo Bay. About 500 ft above the bridge are outcrops of ancient lava flows forming a series of steps over which flow sparkling mountain waters in a unique waterfall. The river banks from the bay to the falls average 35 ft in height and are covered with tropical vegetation—palm, banana and coconut trees, ginger and bamboo bushes, and flowers of many varieties.

Although the Islands are of volcanic origin, foundation problems are as common here as elsewhere because of the wide variations in the character of lava flows of different periods. The utility of a volcanic formation as a foundation depends on the age and quality of the flow, depth from the surface, and degree of disintegration, if any. Preliminary investigations in this case revealed, at the south abutment, a sound lava formation of considerable depth, locally called *pahoehoe* (meaning hard rock) and known to have a high bearing capacity. This provided a safe and stable footing. Conditions at the north abutment, however, were entirely different and borings showed the formation to be composed of a series of layers of varying depths consisting of decayed rock, mud flows, and volcanic conglomerate, covered by a soft rock crust about 18 in. deep. This formation was found to be unreliable with a tendency to compress and eventually produce settlement. For this reason the north abutment was built on reinforced concrete piles 16 in. square in section and 40 ft long, spaced about 3 ft from center to center in both directions.

The arches of the bridge have a clear span of 168 ft and a rise of 40 ft. For earthquake resistance they are tied transversely by two cross beams at the crown panel above the roadway and by one cross beam near each end just below the roadway. One reason for the adoption of this design was the desire to avoid piers in the river itself, because it is 35 ft deep in the center and subject to destructive flows.

These same conditions made it most undesirable to use river footings for the falsework, and accordingly timber trusses spanning the river were resorted to so as to eliminate the danger of washouts. The spans of these trusses were reduced to 140 ft by building temporary concrete piers on the shallow banks 15 ft from the abutments. The trusses were assembled three miles from the site on the shore of Hilo Bay, floated to the job, and hoisted into position by means of six spur-geared chain hoists hung on the steel trusses of the old bridge, which had been left in place for the purpose. This construction procedure was possible because the new bridge is wider than the old, making the concrete arches come about 5 ft outside of the old bridge trusses. Four timber trusses were used for the falsework, two under each arch, set apart sufficiently to permit the installation and hanging of the hanger bars from the arches. These trusses were designed to support both the concrete arches and the concrete floor system (Fig. 1). The weight of the latter was transferred to the panel points of the bottom chords by transverse lattice trusses 6 ft deep.

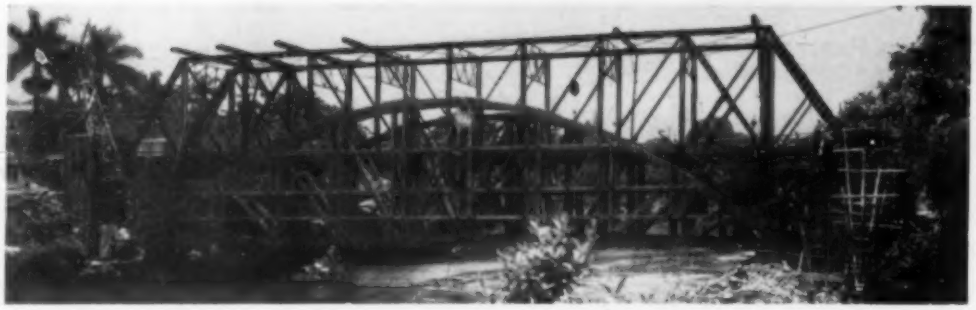
Arches Poured in Three Steps

Concrete arch forms were supported on jacks mounted on the trusses, spaced 8 ft apart, and set above grade by the amount of the computed deflection of the falsework. This was $1^1/_2$ in. at the crown and diminished parabolically to zero at the ends. The arches were poured in three steps in order to reduce shrinkage cracks and to prevent possible distortion or excessive deflection, which would have been difficult or impossible to adjust in time. The middle third of the arches was poured first to produce maximum deflection. This section was cured for 48 hours before the end thirds were permitted to be poured. The delay developed sufficient bond resistance to eliminate the danger of bond-stripping of the reinforcing steel in the middle third—a tendency created by the creeping of the steel in the end thirds caused by additional deflections, which automatically shortened the arch length as

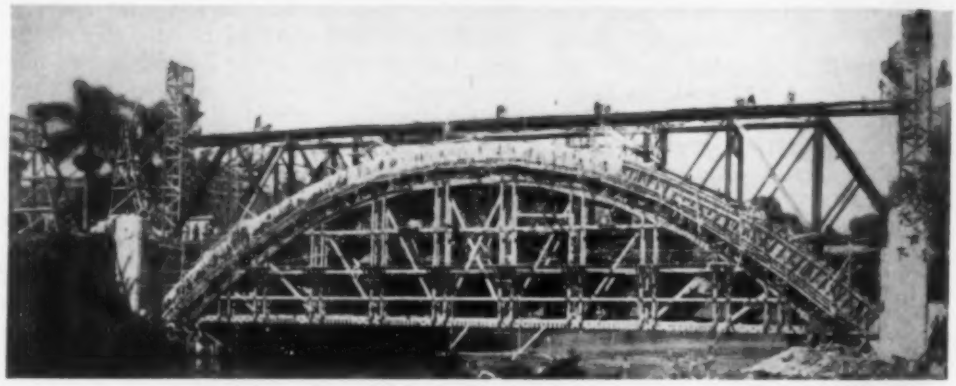
Construction Sequence in Replacing Steel Truss Bridge with Concrete Arch

The Old Steel Bridge

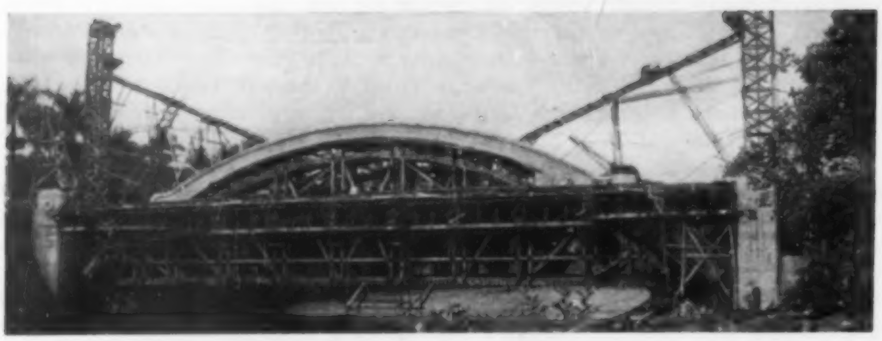
Falsework in Place



At Work on Abutments

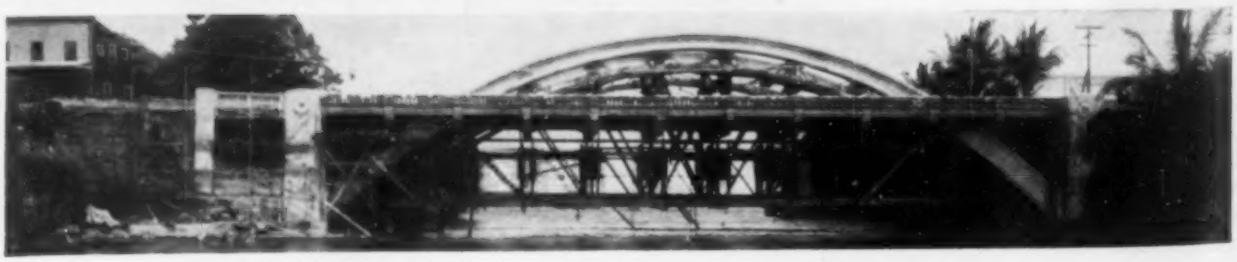


Arch Forms in Place; Pouring in Progress



Old Bridge Removed; Deck Pouring Under Way

Deck Forms Stripped

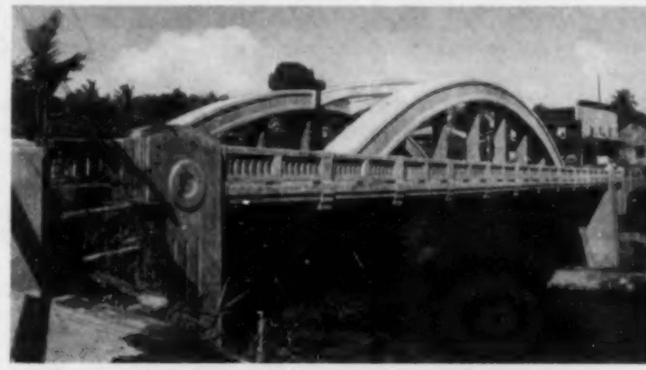


Advances in the Use of Electricity

the end sections were poured. These were then poured to within 3 ft of the center section and allowed to set for 24 hours before the arch was completed. Adequate keys and shear steel were provided at the construction joints. As a result of this procedure, together with practically ideal curing conditions, no cracks developed, not even the almost ever-present "hair-crack." Deflection levels taken at regular intervals during the pour revealed uniform behavior, and no adjustment in the grade of the forms was required. The maximum deflection at the crown proved to be $1^1/_4$ in.

The roadway design is of the standard beam-and-girder type, with sidewalks on each side supported on cantilevers. Before forms for the floor system could be framed it was necessary to remove the old steel bridge. Up to this time it had been left intact with the exception of the floor planks, which had been removed during the framing and erection of the transverse lattice trusses spanning across the bottom chords of the falsework trusses. The first step in dismantling the steel structure was to support it on the falsework. This was accomplished by building up on the lattice trusses until there was full bearing under all the floor beams. These in turn supported the steel trusses, since the floor beams were riveted to the bottom chords. The trusses were then tied to the concrete arches, for lateral stability, by means of light cables. It was now a simple task to remove the old bridge by cutting it into pieces convenient for handling.

With the exception of the two end panels, the floor system is suspended from the concrete arches by means of hanger bars incased in concrete. This type of design is generally employed for steel and is not very common in concrete. Since the falsework trusses were designed to carry both the arches and the floor system, they had to remain in place until both these parts were poured and cured. This procedure necessitated setting the falsework trusses in a position so as not to cut or reduce in size the concrete cross girders supporting the roadway. This was accomplished by setting the top chords of the falsework trusses about 30 in. below the intrados of the arches, thus leaving ample room for form work. In this position the falsework truss members extended above the sidewalk level through the third panels from the end. During the pouring of the floor system it was necessary to leave openings in the sidewalks where the falsework members came through. These openings were framed to produce beveled sides, as shown in Fig. 1. Expansion joints were provided at the center of the roadway and sidewalks, and at the abutments.



The Finished Bridge—Decorative Yet Simple

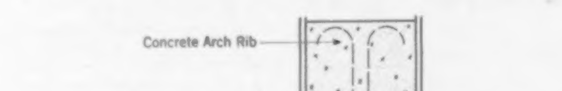


Fig. 1. Diagrammatic Sketch Showing Relative Position of Falsework (Not to Scale)

To compensate for the unavoidable deflection of the falsework, the forms of the floor system were erected and set higher at various points—along the falsework trusses longitudinally and along the lattice trusses transversely.

PROGRESSIVE DEFLECTIONS DURING POURING AVOIDED

The special and unusual feature of the entire construction was the uniform loading of the roadway with pig iron ballast equal in weight to that of the entire concrete floor system, to produce the total dead-load deflection before the pouring of the floor system. The deflection was kept constant as the pouring progressed by removing the ballast in amounts equal to the weight of the concrete poured. This operation was of primary importance because it eliminated the progressive deflection or movement of the floor system relative to the hanger bars, which were stationary and suspended from the already concreted and stationary arches. This in turn eliminated the bond-stripping of the hanger bars then being imbedded in the concrete of the roadway girders. If the ballast had not been used, the deflection of the roadway would have constantly increased as the pour continued and the previously mentioned bond would have been destroyed by the continued movement of the roadway while the concrete was setting.

In removing the falsework trusses, the first step was to make provisions for hanging them from the concrete arches. This provided for, the trusses were cut into pieces of convenient size for handling and removed. The holes left in the sidewalks after members of the falsework trusses had been removed, were filled with concrete and the whole sidewalk surface was then covered with $1^1/_2$ in. of 1:2 topping.

This bridge has now been in service for about a year. It was sponsored by the County of Hawaii, with the Public Works Administration contributing 45% of the \$110,000 total cost. The structure was designed by William H. Chun, project engineer for the county, and built by the Isemoto Contracting Company, general contractor, with T. Wakida as superintendent. The writer was resident engineer inspector for PWA.

learn much more than we know now about the relation

run our imagination and the limitations are not known.

Advances in the Use of Electricity

By Frederick W. Doolittle
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What could easily have been a dull subject is here transformed by Mr. Doolittle into a vigorous interpretation of the progress of a vital force in American life, both domestic and industrial. Avoiding the usual cut-and-dried treatment, he holds the statistical data to a minimum and concentrates on interpreting their economic significance. Then, looking to the future, he outlines several problems to which engineering thought should be given if further advances in the use of electricity are to be assured. This material was originally prepared for the British American Engineering Congress which was to have been held in September.

In dealing with advances in the use of electricity, one might confine himself to a catalog of the quantities used now and in years past for various purposes and processes. With equal pertinence one might recite the development in the number and purpose of the devices through which, in the form of light, heat, or power, electric current has been made increasingly useful to the consumer. A survey of the technical field would likewise be pertinent and of interest. Recent developments in the use of electricity in illumination, in heat applications, in communications, including television, and in the great number of mechanical devices ministering to our comfort and convenience, as well as to economy in production, provide an almost limitless field. But here I would like to handle the subject from a somewhat less technical viewpoint.

Use of electricity, measured as kilowatthours per capita, is high in the United States. It is high both as compared with use in many other countries and with use in this country in past years. In 1938 the output was about 1,100 kwhr per capita, of which 80% was generated in central stations. Central-station output in 1929 was nearly 50 times what it was in 1900. From 1929 to 1938, a 9-year period of depression and stagnation, central-station output continued to increase but at a lesser rate and irregularly, domestic use growing by nearly 90% while all other uses, largely industrial and commercial, increased less than 15%.

The factories of the United States provide about 5 hp of mechanical energy per worker, or perhaps twice that available in the factories of five other principal industrial countries where the range is between 3 and 2 hp per worker. Kilowatthours used in industry contribute to the production of wealth in the form of capital and consumer goods; these in turn fix our standard of living, so that the social implications of the use of electricity are not to be found in domestic consumption alone. It is then of interest to compare the growth in domestic use, that is, the use of the ultimate consumer, with other uses where electricity enters into commerce.

COMPARISONS OF DIFFERENT TYPES OF USE

Classifications of use prior to 1926 are not satisfactory for comparisons with later years, and since that date even the best estimates, those of the Edison Electric Institute, need some interpretation. For example, during the 12 years from 1926 to 1938 about 1,100,000 farm customers were added to central-station lines with an increase of use by all farm customers from 700 million to 2,500 million kwhr per year. However, the significance of this will be clearer if farm uses east and west of the 100th meridian are set out separately. This somewhat arbitrary geographical division separates the territory on the east, where there is little or no irrigation, from that on the west, where agricultural pumping is or may be involved and where use of electricity on farms is to a considerable extent industrial. Comparing the two situations, it appears that from 1926 to 1938, farm use in the East increased 10 times while that in the West increased $2^1/_2$ times, the use per customer meanwhile declining 25% in the West and increasing nearly 80% in the East. Among the many factors contributing to this disparity it should be noted that the primarily industrial use on the Western farm is between 4 and 5 times as great as the primarily comfort or convenience use on the Eastern farm.

Edison Electric Institute reports kilowatthours sold under these headings: farms, residential, small commercial, large commercial, street lighting, street railways, electrified railroads, municipal, and miscellaneous. Combining the farm and residential classes, we have the principal comfort and convenience use, though it does contain some commercial use. Similarly, the combined large and small commercial classes are the best measure of commercial and industrial use. Neglecting the other classes, which together amount to from 10 to 12% of the total, progress in these two main categories during the past 12 years is compared in Table I.

Table I. Progress in Comfort and Convenience Use Compared with That in Commercial Use During Past 12 Years

Year	Residential, Including Farm		Large and Small Commercial	
	Kwhr	%	Kwhr	%
1926	7,450	100	41,477	100
1927	8,399	112	45,306	109
1928	9,807	131	49,407	119
1929	11,128	149	56,077	135
1930	12,491	167	54,091	130
1931	13,252	178	50,481	121
1932	13,073	175	43,070	104
1933	12,992	174	45,446	110
1934	14,090	189	49,221	119
1935	15,188	204	54,453	131
1936	17,130	230	64,267	155
1937	19,264	258	71,104	171
1938	20,989	282	63,216	153

Relatively, domestic use shows much the greater and more uniform advance, while absolutely, commercial use, from 1926 to 1938, increased 1.6 times as much as domestic use. A decline from the previous year occurred twice in the case of domestic use, four times for commercial; and measured in terms of use at the beginning of the period the commercial declines were six times as severe. Commercial use first fell off in 1930, but it was not until 1932 that domestic use first showed the effect of business conditions. In 1933 commercial use again began to rise, followed in 1934 by an increase in domestic. Again in 1938 there was a sharp decline in commercial use while domestic increased. Apparently 1939 ran ahead of 1938 in both groups. Salesmanship, industrial activity, customers' earning power, progress of invention, substitution of electric for competitive services, type and level of rates, rainfall in irrigation areas, all these and many other factors contribute to advance in use of electricity, and if this advance is to reach its fullest measure we must

learn much more than we know now about the relation between promotional forces and acceleration of use.

The differences in the advances cited are a challenge to the statistical analyst. They are accounted for to some extent, I suppose, by the delayed effects of the dislocations of war and the hardly less serious dislocations accomplished by those trying to repair the dislocations of war by trial and error, where no formula of mathematical exactness exists. In this field there has been no Bernoulli, no Newcomen, no Francis. It is perhaps too much to hope, in view of the painful lack of progress in the past, that somewhere there is a Faraday to be followed by a Maxwell, producing a formula dealing with the dynamics of peoples and races, whose work in turn a Hertz and a Marconi of a later generation may understand and apply. From Clerk Maxwell's equations to world-wide broadcasting, science took no backward steps though at first the pace was slow and faltering. The electro-magnetic theory of electric waves oriented progress. Unhappily for our social and economic progress, personal magnetism and waves of emotion do not appear to be similarly controllable or predictable phenomena, nor are they likely to be expressed in the language of mathematical physics. Nevertheless we hope that future years will see a return to advances in commerce, measurably free from the hazards of political upheaval, recalling the past when enterprise faced its problems with a confidence not yet shattered by wars and rumors of wars—by ever-changing philosophies of social welfare and political advancement—by the creed that whatever is, is wrong. Full advance in the use of electricity and in the creation of wealth of every sort awaits a regained confidence.

The end of advance in the use of electricity is saturation, but saturation is not a simple concept. There are at least three factors whose functional operations contribute to the result. First, there is saturation of territory, measured by the degree to which an area is covered by service lines. Complete saturation will exist only when distribution systems so cover the territory that no one, city or rural dweller, is beyond the reach of electric service. In 1902, 20% of the communities of 2,500 people and over and 80% of those under 2,500 did not have electric service available. Today practically all these communities have service available, and in addition service is available to 50% of the farm homes.

A second factor is measured by the percentages of total families and industries within reach of existing lines that are taking service. The problem of unwired houses within served territory has practically disappeared in our urban communities. It is progressively disappearing in rural territory. Practically all industries are connected to service lines. Many, it is true, particularly those needing steam for process purposes, still maintain their own power plants, but their number is diminishing.

The third factor in saturation is that of the current-using device. The limitations here are as yet unknown. The electric range, radio, refrigeration, and now air conditioning, with a myriad of small devices, have been added to illumination in the domestic field, and the end is not yet. Commercial application in lighting and air conditioning are steadily advancing and industrial use adds electrolytic processes to light, heat, and power.

Saturation measured in terms of territory covered is nearing, except in regions of such sparse settlement that central-station service is not economic; in terms of the percentage of actual to potential customers, future growth is measurably limited to growth in population and in industries, but in the multiplication of uses, domestic, commercial, and manufacturing, invention so far has outrun our imagination and the limitations are not known. There are, however, in this field two limitations that we can by no means disregard: the cost to the customer, including the equipment through which electric current is used, and the physical limitations imposed by modern urban housing. Small apartments are economical of light, heat, and power, a condition in part offset by the substitution of convenience devices for domestic servants.

During the period 1926 to 1938, kilowatthour sales of domestic energy increased about three times, with some interesting changes in the relative use for different purposes. From estimates of the Edison Electric Institute, it appears that in 1926 radio absorbed about 1%, and in 1938 10% of the total domestic kilowatthours. In the same period refrigeration advanced from 2 to 22% of the total of domestic use. In the meantime lighting declined in relative position from 65 to 34%, while in the aggregate this use increased by 2 billion kwhr. The range, while increasing its use of kilowatthours by a billion, nevertheless declined from third place in relative importance to a tie with radio for fourth and fifth places (Table II).

TABLE II. ALLOCATION OF DOMESTIC ENERGY SALES TO VARIOUS USES, IN PER CENT (EDISON ELECTRIC INSTITUTE)

	1938	1926
Refrigeration	22	2
Radio	10	1
Range	10	13
Water heater	7	4
Other appliances	17	15
Light and miscellaneous	34	65
	100	100

Without going into the voluminous details involved in such a computation, it is of interest to note that the capital investment of a modest household, prerequisite to its taking full advantage of electric service, will run to about $750. This will provide range, refrigerator, radio, washing machine, vacuum cleaner, and flat-iron, together with house wiring and a reasonable amount of lighting. The supplier of electric current must also make a capital investment of as much or more. The customer, though he may not realize it, carries a capital charge of some $90 per year on his own investment in addition to the cost of current, which for the equipment noted, will average, say, $70 per year. As an interesting study I suggest two comparisons: (1) the first cost and annual operating expense of various devices, and (2) the cost per kilowatthour of the machinery of production as compared with that of the devices of consumption.

One of the most interesting advances in the use of electricity has been in illumination. Probably the best statistics on this subject have been privately prepared and distributed but have not yet been published. The figures relate to all illumination, not domestic alone, and show a cost to the user per million lumen hours of $71 in 1900 and $3 in 1934, with an increase in lumen hours per capita in the lamps sold from 8 in 1900 to 2,200 in 1934. From 1890 to the present there has been an almost continuous reduction in cost per lumen hour, occurring under three headings—decreased cost of the lamp in terms of its life, its increased efficiency, and the decreased cost of current. From 1890 to 1934 the cost of the average incandescent lamp decreased about 60%, its life increased about 30%, and its efficiency nearly 500%. In the meantime, the cost of current has decreased to about one-fifth of its original price. These factors are not independent variables in our cost equation, but a general picture of their effect may be given as follows:

Had the only change in 44 years been in the price of the lamp, the cost of illumination would have declined

5%. Had the only change been in lamp efficiency, it would have declined 80%. Had the only change been in the lamp cost and its efficiency, there would have been a decline of about 82%. But in the meantime the cost of current declined nearly 80%, and the combined effect is to decrease the cost in cents per thousand lumen hours from 7 to 0.3, or by 96%.

Here, it seems to me, we have an exemplification of the interplay of economic factors in a free economy which is of significance. Economies have resulted from increased volume in production of lamps, from increased volume in production of kilowatthours, from invention and improvement in processes, and from the continuous, earnest, and effective study of engineers. Neglecting for a moment the fact that the increase in use of current for other than lighting has contributed in dominant degree to the decrease in cost of producing current, and that the development of manufacturing in various lines has contributed to reducing the cost of electric lamps, there is still this phase of the process of cost reduction that warrants thought. The manufacturer might have held the price of the lamp fixed and increased either its efficiency or its life in a greater degree, or the efficiency and life might have been held constant and the price reduced still further. As a practical solution some of the economy of mass manufacture has appeared in each of the three factors—first cost, life, and efficiency. Similarly the economies in increased production of electric current might all have been reflected in lower rates for industrial use or all applied to domestic service, or the economies might have been reflected in subsidizing the manufacture of current-using equipment. In fact, this has been experimented with from time to time through the supplying of free lamps to domestic service customers.

The student of these problems, realizing that there is no single generally accepted theory of determination of costs in the production of electric energy, may be puzzled to know whether the economies achieved have been correctly shared. The load factor, or more accurately the comparative demand curves, of the several types of users of an unstorable product are important factors, yet so far there has been no general acceptance of the theories of Hopkinson, Greene, Wright, and others concerning direct and common costs; and even if one could determine the precise cost of serving each individual customer or each class of customer, rates rigidly related to cost are by no means necessarily in the interest of each group. Clearly alternative sources of supply as well as competitors' costs fix a ceiling above industrial rates. Other classes cannot afford to have this business lost to the supplier, for its magnitude and characteristics contribute greatly to lowered production costs. We ought not to give any one class of customers an advantage at the expense of other classes, attractive as such strategy may appear, but the facts are not easily determined. A sound objective is to reach such a distribution of costs among the different groups as will result in the maximum possible addition to the wealth of the community. This can result only when the unit costs of production both of the electrical energy itself and of the articles of commerce into which it goes, are at a minimum.

In industry there is a phenomenon with which we are all familiar. Industry seeks to establish itself where fixed costs and operating expenses are low, raw materials conveniently at hand, and markets readily available. Obviously it can but rarely find a location that gives it each of these advantages. Assuming that it elects cheap land, low taxes, and convenience to raw materials, it will then presently be heard to ask for a subsidy from railroads to put it on an equality with its competitors as regards freight rates to markets. Other competitors, electing to locate near their markets, will then be heard to ask for subsidies from the railroads for the assembling of raw material; that is, the enterpriser desires to obtain as many natural advantages as possible without assuming the burdens entailed thereby.

We have a similar situation where certain users of current for domestic purposes desire to retain the advantages of rural and suburban life and yet pay the same rates per unit as those who live near the centers of production and distribution or who are so equipped as to be served cheaply. With this desire one cannot quarrel; it is natural in all human relations. But there can be no miracles, there can be no white rabbits pulled from silk hats; the community as a whole, whether as other customers or as taxpayers, must carry the costs of service to those customers, the nature of whose use entails costs exceeding their willingness or ability to pay, and perhaps even the value of the service.

PROBLEMS AWAITING SOLUTION

It has been possible in this brief discussion merely to suggest a few of the problems affecting advance in the use of electricity. The engineers who practice in this field, either as administrators or technicians, are daily confronted with these and other problems, the number and variety of which bear testimony to the fact that the resolution of political, economic, and social forces is often neither simple nor painless. The adoption by the social scientist of the technique of the engineer, and the acceptance by the engineer of slogans as axioms will not bridge the gap between plan and performance in the complex field of political planning.

In the meantime we do go forward. We have continually improved the technique and cheapened the cost of producing electricity and of delivering it to users; we have assembled the necessary capital and made service widely available; we have perfected devices profoundly affecting the processes of industry and promoting comfort, convenience, and entertainment in the home. These things have been accomplished under competition in the capital and equipment markets and regulated monopoly in the central-station field. More recently suppliers of current have been faced with competition by the federal government and by lesser authorities subsidized by federal funds—both relieved of state regulation, taxation burdens, and the responsibility of uniform accounting. Time alone will permit an accurate public appraisal of the value of these developments to the nation and to the immediate recipients of the gifts. In the meantime I suggest the importance of engineering thought on the following two problems:

1. How can total cost be made a minimum? How can essential equity capital be attracted to the industry of supply on favorable terms, and how can the consumer be equipped with all the devices of consumption he ought to have? What should be done to improve the cost characteristics of different classes of customers, and what can be done to bring about the most favorable balance between costs of generation, transmission, and distribution?

2. What are the costs of serving the various groups of customers? To which groups and in what amount should subsidies be granted? Who should bear the cost of these subsidies?

The solution of these problems will have an important bearing on future advances in the use of electricity. Of one thing we may be sure—the full costs cannot be avoided however skillfully they may be deferred, distributed, and described.

Studying Sediment Loads in Natural Streams

Highly Specialized Laboratory of Soil Conservation Service Now in Second Year of Operation on Enoree River, S.C.

By Gilbert C. Dobson, M. Am. Soc. C.E.
and Joe W. Johnson, Assoc. M. Am. Soc. C.E.

Respectively Acting Chief and Assistant Hydraulic Engineer, Sedimentation Division, Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

Quantitative measurements of bed load movement, in a natural stream large enough to be representative of rivers in general, are being made almost daily at the Enoree River Laboratory of the Soil Conservation Service. Of special interest because they are the first of their kind, these observations are but part of a comprehensive research program designed to throw light on various problems of sediment transportation, particularly as related to soil conservation work. Messrs. Dobson and Johnson here describe the laboratory, giving particular attention to the unique control structure from which the bed-load samples are drawn. They also describe the technique of the bed load observations, and summarize briefly the other phases of the research program.

The suspended load of sediment in streams can readily be determined by taking samples at a sufficient number of points in a cross section, but the problem of ascertaining the extent of movement of bed load is still only partially solved. Except for a few experiments in natural streams, using specially constructed traps, quantitative studies of transportation of bed load have been limited almost entirely to laboratory flume studies. In no case does it appear that former work has included actual quantitative measurements of sediment in transit in the form of bed load in such streams as are large enough to be generally representative of rivers. Although many serious and admirable efforts have been made to develop rational formulas for expressing the tractive power of streams, and to apply the data from flume studies to natural streams, the various methods suggested do not fully and adequately permit the determination of actual volumes of material transported in such streams.

In formulating a program for the Soil Conservation Service, it was recognized that there was urgent need for extensive information on the factors affecting the amounts, occurrence, and movement of sediment (suspended and bed) in natural streams. Such information is of vital importance in designing and evaluating works for erosion control. A comprehensive program of research therefore was planned, resulting in the construction of a sediment-load laboratory on the Enoree River about 8 miles east of Greenville, S.C., and 2 miles northwest of Pelham, in the Piedmont Plateau region.

In planning the program of this research project, the work was divided into four sub-projects that would throw light on the problem of sediment transportation as related to soil conservation work in particular. These sub-projects are:

1. Development of the relationships of the character and amounts of sediment load to the hydraulic and physical characteristics of the stream.
2. Correlation of data pertaining to the topography, land use, and hydrology of the drainage basin with the resulting erosion as manifested in the amount and composition of the sediment in the drainage stream.
3. Development of practical and simplified methods for determining the total sediment load carried by any stream.
4. Development of methods for controlling the movement of sediment in flowing water.

It is of interest to note that this research program is only a part of the work being carried on by the Sedimentation Division. Other studies of the division that are closely related and coordinated with these are (*a*) investigations of the factors affecting the processes, rates, and control of reservoir silting; (*b*) investigations of the causes and effects of silting damage to stream channels and valley agricultural lands; and (*c*) laboratory investigations of the fundamental mechanics covering the entrainment, transportation, and deposition of erosional debris, in cooperation with the California Institute of Technology, Pasadena.

A straight, undisturbed reach of the Enoree River was selected for the purpose of studying the relations between sediment load and the hydraulic and physical characteristics of a stream. At a section near the center of this reach, arrangements have been provided for velocity and suspended-load observations. A systematic bed-sampling program is also conducted for the purpose of evaluating changes in bed composition.

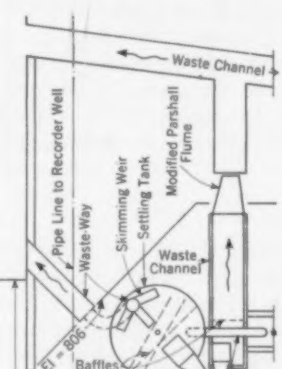
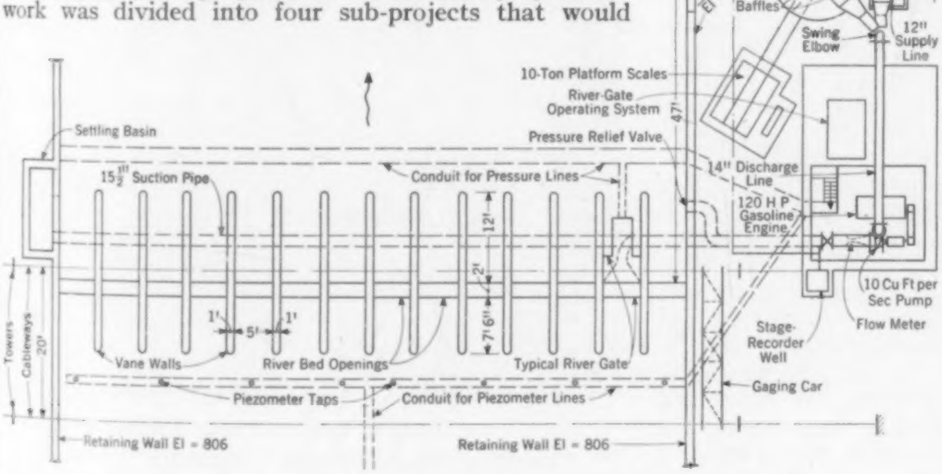

Fig. 1. General Plan of Enoree River Sediment-Load Laboratory

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A short distance downstream from the lower end of the reach a new-type control has been constructed to permit accurate measurement of the total sediment load of the river. In the operation of this control two sampling procedures are used to determine the sediment load. One portion of the load, consisting of the relatively coarse fractions moving on or near the bed, is removed hydraulically by pipe connection and pump from openings in the stream bed. This material is discharged into a settling tank, from which it is later removed to be weighed and analyzed for particle size. The remaining portion of the stream load, consisting of the material that does not pass into the bottom openings, is determined by suspended-load samples taken simultaneously with the pumped samples at a point immediately downstream from the bed opening. This material is also subjected to an analysis for the determination of particle size. The results of these two procedures are combined to give the total load of sediment passing the control.

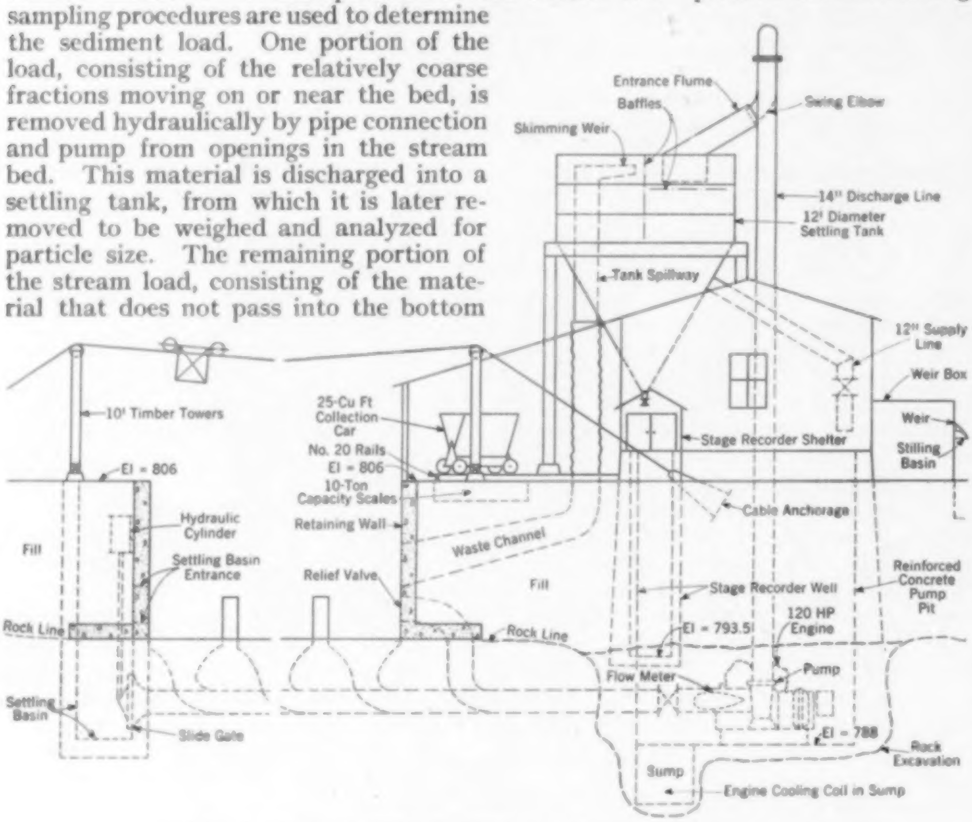


FIG. 2. SECTIONAL ELEVATION OF CONTROL STRUCTURE

DETAILS OF THE CONTROL STRUCTURE

In Figs. 1 and 2 the control structure and its appurtenant features are shown. In constructing the control, the channel section was reshaped for approximately 100 ft along the stream by concrete retaining walls and pavement resting on rock. It was designed to pass a flood equivalent to the maximum observed in the Piedmont region and evaluated for the Enoree River drainage basin above the control on the basis of the Myer relationship. The reshaped channel at the lower end of the paved reach is divided into 14 subchannels by low longitudinal concrete vane walls (Fig. 3).

Across the main channel, near the lower end of the vane walls and $4^1/_2$ ft below the bottom of the river, is a $15^1/_2$-in. header pipe which connects, by transition section and elbow, with bottom openings in each of the subchannels (Fig. 4). This header pipe extends directly, without bends, into a pump located in a reinforced concrete pit on the right bank. The bottom openings in all subchannels are 5 ft wide and 2 ft long, and are covered by slide gates with upper surfaces flush with the stream bed (Fig. 5). To prevent large material from entering the system, a grating of heavy construction with 3 by 3-in. clear openings is located immediately under the gate plate and covers the complete river-bed opening. The river gates are protected against uplift pressure, resulting from backflow upon pump shutdowns, by a flap-type relief valve located in the header pipe between the pump pit and the first river gate. These river gates are controlled by oil pressure in double-acting hydraulic cylinders, and can be operated independently of each other. Small positive-displacement oil meters are located in one of the two pressure lines which lead to each of the hydraulic cylinders. The meter dials are calibrated against gate opening and thus permit a gate to be accurately placed in any position between completely open and completely closed.

On the left bank of the river the header pipe terminates in a reinforced concrete well. This well, provided with an opening through which water may enter from the river, acts as a settling basin from which relatively sediment-free water may be drawn for flushing the header pipe. Flow through the header pipe from the well is controlled by a hydraulically operated rectangular gate.

Most of the machinery and equipment necessary to the operation of the control is installed in the pump pit and the shelter over it. The larger part of the space in the pit is occupied by the pump and the 120-hp marine-type gasoline engine that drives it. The pump has a normal capacity of 10 cu ft per sec with a 36-ft head, and a maximum capacity of 20 cu ft per sec with a 43-ft head. A slide valve has been installed in the suction pipe (an extension of the $15^1/_2$-in. header pipe) to permit repairs to be made on the pump without danger of flooding, as the bottom of the pit is below the bed of the river. Between this valve and the pump a modified venturi flow meter has been installed in the suction line and cali-

FIG. 3. GENERAL VIEW OF CONTROL STRUCTURE
Note Gaging Car Suspended from Cables. Sediment Analysis Laboratory Is Housed in Building in Background

brated in place. This flow meter, which has contractions at the sides only, is of the type described by the late Floyd A. Nagler, M. Am. Soc. C.E., in *Engineering News-Record* for August 3, 1933, page 132. The cooling coil for the engine, a sump pump, pressure lines leading to the river gates, and other appurtenances are located in the pump pit. In the shelter over the pit is the gate-operating system, which consists of a rotary pressure pump, pressure tank, oil-storage tank, header pipes, four-way control valves, oil meters, and the necessary piping.

Fig. 4. Transition and Precast Elbow Assembled to Show Relation Between Bed Opening and Header Pipe

At one side of the pump pit is a stage-recorder well. The pipe line leading from the recorder well to the river intake passes through a corner of the pump pit and is provided with valves and piping to permit its being flushed by water from the discharge line of the large pump.

The sediment-laden water discharged from the pump passes through a 14-in. pipe either into a separating tank or to a wasteway that returns it to the river. A swing elbow, controlled from ground level, permits this diversion of flow. The separating tank, 12 ft in diameter and 6 ft high, with a 60° conical bottom, is provided with an entrance hood, baffles, and a waste way skimming weir. The tank is designed for continuous operation; that is, during sampling runs, the pump discharge flows continuously into the tank. At frequent intervals during operation the sediment that has settled in the tank is flushed through a 3-in. quick-acting valve located at the apex of the conical bottom into a small weighing tank.

This weighing tank is an industrial railroad dump car of 25-cu ft capacity, provided with a piezometer tube which is calibrated so that the volume of water and sediment contained in the tank can be easily determined. For obtaining a time record of the weight of material collected, the car is weighed on 10-ton platform scales after each periodic flushing of the separating tank. The specific gravities and the volume and weight of water and sediment being known, the amount of material collected can be converted into weight of dry material. After the material collected in the dump car has been weighed, it is split and a sample sent to the laboratory for mechanical analysis. The remainder of the collected material is returned to the river.

Extensive experiments, in which sand of known amount and mechanical characteristics was introduced into one of the river openings and collected in the tank, have permitted the solid-removing efficiency of the tank to be determined over a wide range of discharge. The experiments showed that, for a given discharge and particle size, the efficiency of the tank is constant for all concentrations that are encountered in practice. Therefore, to obtain the mechanical analysis of the material which enters a particular river-bed opening, it is only necessary to take a sample of the material collected in the tank, subject it to mechanical analysis, and apply to the quantity of material of each particle size a correction determined from the efficiency tests.

As previously stated, suspended-load samples are taken at a certain section in the natural reach and at the control structure. The samples in the natural reach provide data to be used in applying and checking the various theories of silt transportation. These samples and the necessary determination of observations of velocity are obtained from a cableway of the type ordinarily used in stream gaging.

Fig. 5. Looking Downstream at River Gate, Prior to Grouting. Cover Plate Over Hydraulic Cylinder Removed to Show Piping

The sediment samples taken at the control as part of the total load determinations are obtained from a specially constructed double-track cableway (Fig. 3). The car is of such length that suspended-load observations can be made in the vicinity of the gate openings and discharge measurements can be taken by current meter a short distance upstream from the vane walls. It is hand propelled from the car by a system of sheaves which reel and unreel on tightly stretched $^1/_8$-in. cables anchored to the main cable towers.

MEASURING THE SUSPENDED LOAD

Routine suspended-load observations at the natural section and at the control are made with the Anderson-Einstein sampler shown in Fig. 6. It consists primarily of an ordinary pint milk bottle equipped with a two-hole rubber stopper through which $^1/_2$-in. copper tubes are provided for intake of sediment-laden water and escape of air. This sampler fills gradually and causes very little disturbance of flow. Because the sampler can be placed in position quickly, no valve arrangement on the entrance and exit tubes has been found necessary to prevent filling

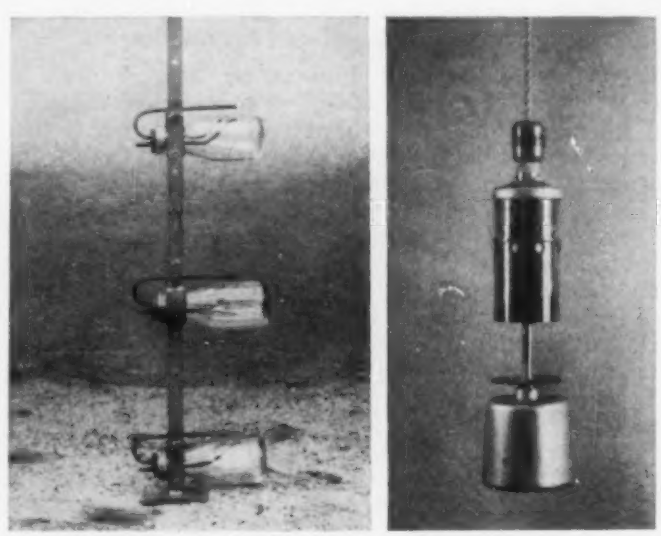


Fig. 6. Suspended-Load Samplers Developed in the Division of Sedimentation

Left: Multiple Arrangement of Anderson-Einstein Sampler. Right: Eakin Sampler in Open Position

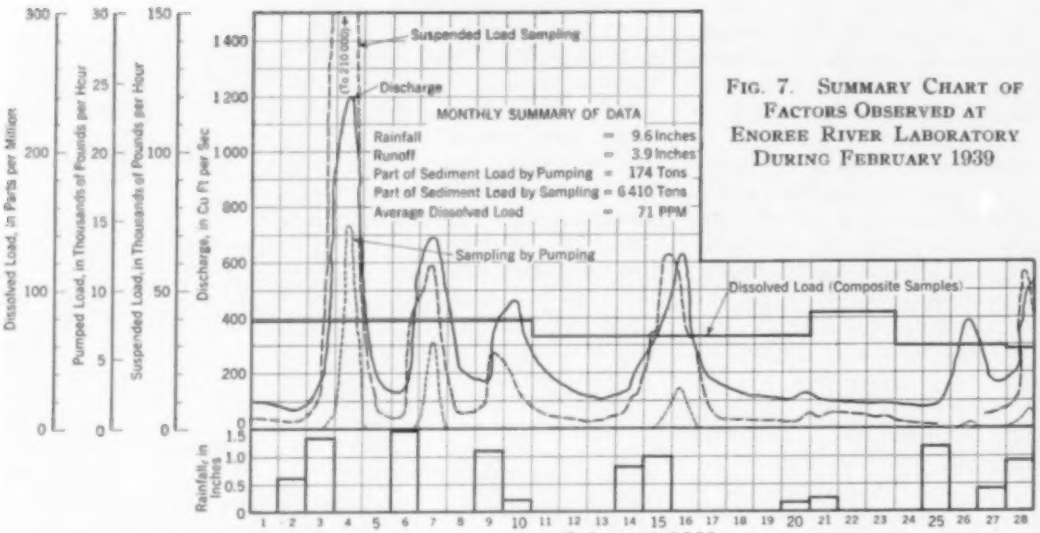


FIG. 7. SUMMARY CHART OF FACTORS OBSERVED AT ENOREE RIVER LABORATORY DURING FEBRUARY 1939

to commence before the desired sampling point is reached. This type of sampler has several advantages, the most important of which is that it also may be used as a flow meter after careful calibration. Other advantages are that (*a*) a time average instead of an instantaneous sediment concentration at a point is obtained; (*b*) several sampling units may be easily mounted on a single rod to obtain a vertical distribution of sediment; and (*c*) the sample need not be removed from the sampler before being taken to the laboratory.

For cases where an instantaneous grab sample is desired, the Eakin-type sampler (Fig. 6) is used. This sampler consists essentially of a brass tube which, when released by a messenger weight dropped down the cable to strike a trigger, is forced downward by a spring and seats upon a rubber-faced base plate to trap a sample of water. The sample is removed by holding the sampler over a funnel and forcing the brass tube back to the "cocked" position. For convenience, when removing the sample, the rather heavy weight can be detached by means of a convenient bayonet-type locking device. For use in high-velocity streams, an ordinary current-meter weight is substituted for the round weight shown in Fig. 6.

OTHER OBSERVATIONAL EQUIPMENT

Precipitation data are obtained by 10 recording rain gages distributed over the 64.4 sq miles of contributory drainage area. The data from these 10 gages and from 3 gages on the adjacent drainage basin are used in the construction of isohyetal maps, which show the geographic distribution of hourly rainfall.

To supplement the river observations on sediment-load movement, a concrete flume 5 ft wide, 30 in. deep, and 50 ft long, provided with a measuring weir, a sand-feed elevator, a sand trap, and a tail gate has been installed for studying the transportation of various sand mixtures under definite controlled hydraulic conditions. Tests in the flume are conducted only during low-water seasons, when the river water is relatively clear. Water for use in the flume is pumped from the river into the settling tank, which is provided with a skimming weir and serves as a constant-head tank. A maximum discharge of approximately 8 cu ft per sec may be obtained from the constant-head tank.

To compare the hydraulic characteristics of the river control with those determined from a model, a large number of piezometer taps were placed at various points in the structure during construction. Several taps shown in Fig. 1 are located in the paved section of the stream bed above the take-out openings. Other taps are located at frequent intervals along the top, bottom, and sides of one of the transition sections and elbows, and along the header pipe of the river take-out system.

A well-equipped laboratory is provided for the complete analysis of all sediment samples from the Enoree River. Various samples are also analyzed for the Reservoir Section and the Stream and Valley Section of the Sedimentation Division. A ro-tap machine is provided for analyzing relatively coarse material, and there are hydrometers, pipette equipment, small-diameter sieves for wet sieving, and a microprojector for analyzing fine-grain sediments. There is also equipment for determining the dissolved load, specific gravity, and particle fall-velocity, and for petrologic analyses.

Space for sample storage and a shop is provided in the rear part of the laboratory building. The shop is equipped with welding, blacksmith, and other equipment necessary for making repairs and for constructing various types of special equipment.

NATURE OF THE DATA COLLECTED

Figure 7 shows a summary of the various factors observed at the Enoree laboratory during the month of February 1939. Although not included in this paper, graphs are available which show a continuous record of stream load according to various particle sizes. In this connection it is to be noted that in the data gathered to date rather definite relations exist between load and discharge for the coarser materials, but for the very fine material, constituting the majority of the load obtained by suspended-load sampling, no definite relation appears to exist between load and discharge. This latter condition is to be expected, as the quantity of very fine material in a stream depends on drainage-basin factors such as rainfall, runoff, vegetative cover, tillage methods, and surface and underground storage. Extensive preliminary experimenting was required to ascertain the range in value of anticipated data and the capacity of the control for handling these ranges and to calibrate parts of the control. Continuous records of the hydraulic functions and the sediment loads of the stream have been maintained since January 1, 1939.

The late Henry M. Eakin, while chief of the Sedimentation Division, conceived the experimental procedure and obtained authorization for the project. The development of the laboratory was made possible by his active interest and support. The control and its appurtenances were designed by the junior author under the supervision of the senior author. During the design and construction of the control, valuable suggestions were made from time to time by Alvin G. Anderson, Jun. Am. Soc. C.E., Dr. H. A. Einstein, Fred E. Tardy, Richard G. Grassy, and Alvin T. Talley.

The Challenge of the Continental Divide

First of Three Articles on Railway Routes Across the Rockies

By Ralph Budd

Member American Society of Civil Engineers
President, Chicago, Burlington, and Quincy Railroad, Chicago, Ill.

After overcoming the barrier of the Appalachians and spanning the central plains, the railroads were faced with the most formidable task of their career—the crossing of the Rockies. It was less than ninety years ago that Congress authorized the Pacific Railroad Surveys, with a view to solving the problem, and within 16 years the first transcontinental line was in operation. In this article Mr. Budd relates the historical background for the sensational feats later accomplished by the railroads in actually laying rails through the passes of the Rockies. In later issues he will continue with a discussion of the routes chosen by the nine transcontinental railroads which now operate 13 routes across the divide. These articles by Mr. Budd constituted the annual dinner address for 1938 of the American Branch of the Newcomen Society.

The steam railway has played a peculiarly vital role in shaping the history of the United States of America owing especially to the time at which it came upon the scene. Very soon after the birth of the new nation, it was realized that the great regions drained by the Ohio and Mississippi rivers could carry on commerce with foreign countries through the natural avenues of those streams and their tributaries, more easily than they could trade with the original 13 states. This, of course, was because of the barrier presented by the Appalachian Mountain system. To overcome that handicap every effort was made to provide effective means of communication between the Atlantic seaboard and the West according to the standards of the times. In the eventful decade of the 1820's, rails and the steam-driven vehicle appeared, and by 1838, only a hundred years ago, railroads had so far demonstrated their superiority for transporting people and goods that Congress discontinued appropriations for the national highway, the Cumberland Road, after the construction had reached about to Vandalia, then the capital of Illinois.

The railroads had proved their ability to surmount the Appalachians, and their potentialities fired the enthusiasm of expansionists absorbed with the Oregon question. Under the treaty of joint occupancy with Great Britain, nationals of both countries were settling in Old Oregon, and these people eventually determined for themselves their choice of allegiance. California and New Mexico still belonged to Mexico, so the uttermost western boundary of the United States a hundred years ago was the Rocky Mountains. But that barrier was so formidable that gravest doubts were entertained as to the practicability of crossing it except on foot or by pack horse.

The importance of knowing more about the territory beyond the mountains was obvious at the time of the Louisiana Purchase, so President Jefferson extended the investigations to the Pacific, and authorized what became the brilliantly successful Lewis and Clark expedition of 1804–1806—one of the outstanding examples of simon-pure official exploration.

Missionaries, trappers, traders, hunters, explorers, and emigrants made many trips through the Rockies at various places during the first half of the nineteenth century, and their journals and narratives are filled with information of the country. William H. Ashley reported in 1825 that wagons could be taken across and in 1827 he sent a piece of mounted artillery to Great Salt Lake. But I believe the first to assert positively from personal observations that a railway could be built across the mountains was Samuel Parker, a Presbyterian minister, who went out over the Oregon Trail in 1835. Marcus Whitman was in Parker's party and turned back at about the continental divide. The next year he led a party of his own and took a wagon as far as Fort Boise, thus demonstrating that the mountains could be negotiated by wheeled vehicles. These two preachers, Samuel Parker and Marcus Whitman, insisted a hundred years ago that the route was practicable for a road rather than a mere trail.

From the Painting by Lane K. Newberry

South Pass, Wyoming, the Route Followed by Hosts of Mormons, Oregon Immigrants, and California Forty-Niners

Although many promotion schemes appeared, the distinction of presenting a complete plan for a transcontinental railway belongs to Asa Whitney. As early as 1844 he was pressing vigorously for an Act of Congress to authorize and assist such a project. John C. Fremont in 1842–1844 reported feasible routes to the Columbia, but not necessarily for railways. How very deep-seated and persistent was the traditional idea that high mountain ranges constitute natural frontiers, is shown by the fact that notwithstanding the many reports that had been circulated and even the extensive emigration that had taken place, Daniel Webster in an address as late as 1845 was saying:

"Where is Oregon? On the shores of the Pacific, three thousand miles from us and twice as far from England. Who is to settle it? Americans, mainly, some settlers undoubtedly from England, but all Anglo-Saxons; all men educated in nations of independent government and all self-dependent. And now let me ask if there be any sensible men in the whole United States who will say for a moment that when fifty or a hundred thousand persons of this description shall find themselves on the shores of the Pacific Ocean that they will long be content to be under the rule of either the American Congress or the British Parliament? They will raise a standard for themselves and they ought to do it....

"I believe that it is in the course of Providence and of human destiny that a great state is to arise, of English and American descent, whose power will be established over the country and the shores of the Pacific; . . . so there will exist at the mouth of the Columbia, or more

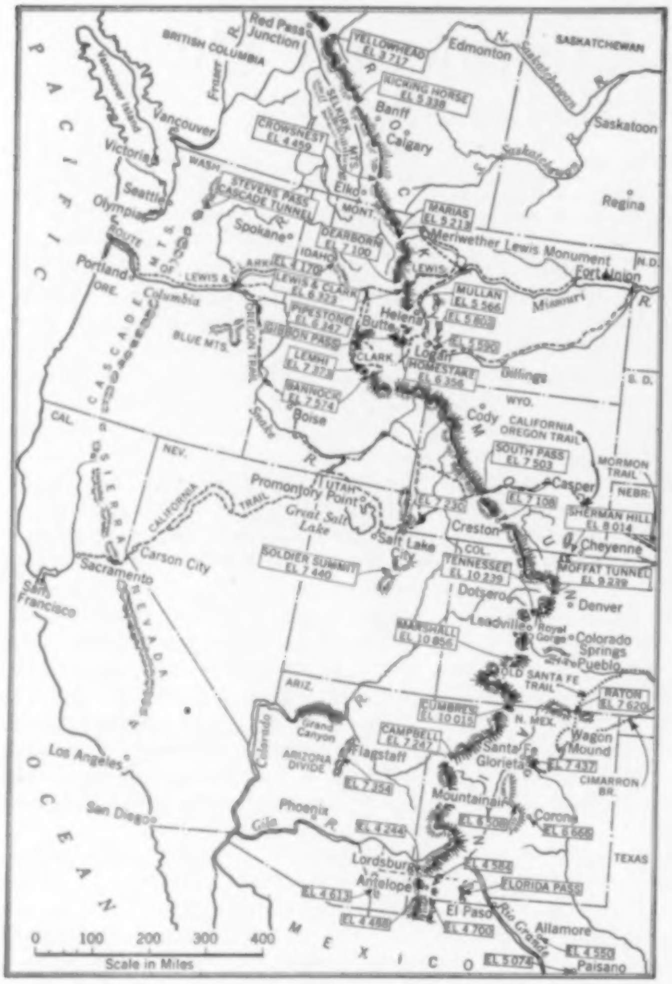


FIG. 1. ROCKY MOUNTAIN REGION, SHOWING PASSES AND EARLY TRAILS

probably farther south, a great Pacific Republic, a nation where our children may go for a residence . . . forming an integral part of a new government halfway between England and China."

OVERCOMING THE "GREAT RANGE" CAPTURES THE POPULAR IMAGINATION

Already, in 1843, the people of Oregon in the memorable Champoeg election had chosen to organize a settlers' provisional government, a first step toward the formal creation of Oregon Territory under the stars and stripes. Two years later Texas joined the Union; California and New Mexico were annexed early in 1848, rounding out our continental expansion except for Alaska and the Gadsden Purchase. Thus transcontinental railways became a prime national necessity in addition to their importance as trade routes between Europe and the Orient. Overcoming the obstacle of the Great Range by throwing a railroad across it was a topic of common debate and almost universal consideration.

Of course, it was well known that there were other mountains lying between the crest of the Rockies and the Pacific—indeed that the entire Pacific slope was more or less mountainous. But the idea of conquering the continental divide which separates the waters of the two oceans captured the imagination of the people, and the divide stood in their minds as the basic barrier between the East and the Far West. The existence and location of most of the Rocky Mountain passes had been reported quite reliably by those who had used them from the time of Lewis and Clark, but this knowledge needed to be officially verified, classified, and correlated. A systematic survey was necessary to determine the accessibility of the various passes, the regions through which the natural approaches to them led, and the directness or circuity of such means of approach from the standpoint of distance between important cities.

The general structure of the Rocky Mountains from the Mexican boundary northwesterly to Yellowhead Pass in Canada, a distance of 1,500 miles, is that of a continuous cordillera, with four regions of relatively low altitude. Four typical passes, one in each of these regions, may be mentioned. The one in New Mexico (altitude 4,700 ft), given the poetic name of Florida on early maps, is where the tributaries of the Rio Grande and the Gila head quite near to each other on opposite sides of the divide. Two of the passes—Mullan (altitude 5,600 ft) and Marias (altitude 5,200 ft) are in Montana. At both of them the headwaters of Missouri River tributaries rise in the mountains only a short distance from those of the Columbia. The fourth is Yellowhead Pass at Jasper Park, Canada (altitude 3,700 ft). The westward-flowing Fraser and the eastward-flowing Athabasca have their sources in Yellowhead, and the continental divide is lower there than in any other pass with which we are concerned.

Between the four relatively low regions just mentioned are the broadest and highest parts of the Rocky Mountain system. These high areas are marked by such well-known features as Grand Canyon National Park, Rocky Mountain National Park, Yellowstone National Park, Glacier National Park, and the famed Canadian Rockies.

It was known that some excellent routes across the mountains were to be found in these high areas. Although they surmount the continental divide at higher altitudes, their advantageous approaches in some instances compensate for the greater rise and fall. For example, the route through South Pass in Wyoming was one of the best known of all. It had been followed more or less precisely in the autumn of 1812 by returning Astorians under the leadership of Robert Stuart, who thereby blazed the way which later became the renowned Oregon Trail. Thereafter innumerable traders, as well as hosts of Mormons, Oregon emigrants, and California Forty-Niners used South Pass.

In the great clamor for transcontinental railways which was started by Asa Whitney and others about a hundred years ago, and the lively discussions that ensued in Congress, there were the sharpest of partisan disagreements. Southerners advocated strongly some route or routes from St. Louis, Memphis, or New Orleans; others pressed with equal enthusiasm for a northern route; still others advocated a central route via South Pass, about which more was known than the others, since it had been traveled so extensively.

PACIFIC RAILROAD SURVEYS INITIATED

The agitation concerning western railway projects culminated in an Act of Congress, passed early in 1853, authorizing and directing the Secretary of War to undertake the Pacific Railroad Surveys to determine the feasible routes from the Mississippi to the Pacific. This achievement may be credited chiefly to Senators Gwin of California, Rusk of Texas, Borland of Arkansas, Bell of Tennessee, Chase of Ohio, Seward of New York, Dodge of Iowa, Douglas of Illinois, and a few others who put national necessity above personal prejudice. Jefferson Davis was Secretary of War and, solely because the scope of the work fell within the duties of that position, he carried out the instructions of Congress. Some acts of

Along the Backbone of a Continent—Once a Formidable Barrier to Westward Expansion

Spanish Peaks, Montana, near Bozeman, on the Route of the Northern Pacific Railway

his savor of sectionalism—for example, his exaggeration of the difficulties of winter operation in the north, and his preemptory orders to curtail explorations under Isaac Stevens at a critical time. I think I should not have mentioned this except for a recent biography of Jefferson Davis, wherein undue credit is given to him for the carrying out of these surveys as well as their conception.

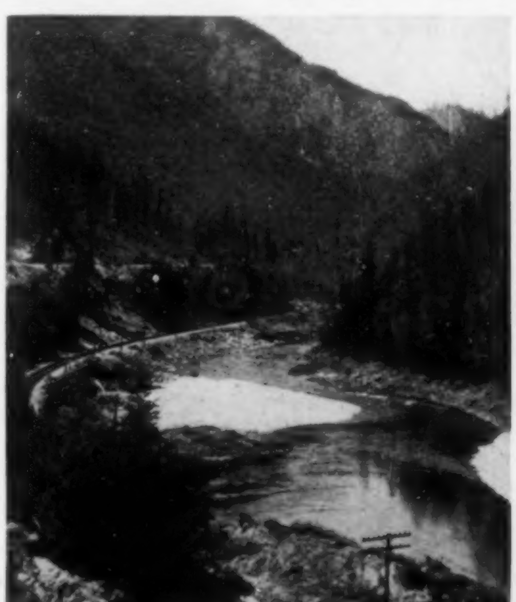
DIRECTIONS TO SURVEYORS

The surveys were begun in the spring of 1853, completed promptly, and reported in 13 large volumes of the *Congressional Record* in 1855. I feel that this report constitutes the most important source material on the West ever published. The Secretary of War, referring to the instructions given to the Army officers in charge, said:

"They were directed to observe and note all the objects and phenomena which have an immediate or remote bearing upon the railway, or which might seem to develop the resources, peculiarities, and climate of the country; to determine geographical positions, obtain the topography, observe the meteorology, including the data for barometric profiles. . . . They were to make a geological survey of the lines; to collect information upon, and specimens of, the botany and zoology of the country; and to obtain statistics of the Indian tribes which are found in the regions traversed. Thus would be obtained all the information for the general consideration of the question, as well as the data upon which the cost of construction, and working a railroad depends."

The work of the Pacific Railroad Survey parties was so monumental that the personnel of those in charge is worthy of note. They were Army engineers, nearly all of whom later were engaged in the Civil War on the side of the Union. The region assigned to the southern engineers was between the thirty-second and thirty-eighth parallels of latitude and was under the direction of Maj. William H. Emory. The region next to the north, between the thirty-eighth and forty-first parallels was under the direction of Capt. J. W. Gunnison, assisted by Capt. E. G. Beckwith. Before their task was completed, Captain Gunnison and seven of his party were attacked and killed by a band of Ute Indians, and Captain Beckwith completed the survey. The northern region, between the forty-fifth and forty-ninth parallels, was under the direction of Maj. Isaac I. Stevens, who was also governor of the newly created Washington Territory.

After the Pacific Railroad Reports were published in 1855, any one who had the desire and diligence to go through them could gain a very fair idea of where and how the great Rocky Mountain barrier could be approached and crossed by railroad lines within the United States. There was one notable exception, the legendary Marias Pass which Governor Stevens heard about from the Blackfoot chief, Little Dog, but was unable to locate within the time limit and expense account which the impatient Jefferson Davis allowed him for the task.



Great Northern Railway Tracks Through Flathead Canyon, Glacier National Park, Montana

If sectional rivalry tended to confusion as to the merits of the various routes, it also resulted in the exercise of great thoroughness on the part of the engineering forces. Weather and meteorology were carefully recorded; especially in the north the practicability of winter operation was stressed. The importance of favorable approaches to the passes was recognized and pointed out.

A remarkably able and complete treatise on the subject of railway construction and operation is contained in Volume I under the caption "Memoranda on Railways" by Capt. George B. McClellan. It contains extensive data on contemporary railways and formulas for determining locomotive tonnage ratings for various grades, as well as a discussion of allowable curvature. The Baltimore and Ohio grade of 116 ft per mile is cited, and it is significant that the Land Grant Acts of 1862 and later years provide that "the grades and curves shall not exceed the grades and curves of the Baltimore and Ohio Railroad." Thus originated the 2.2% grade, which became a common maximum in our western mountains.

In this article I have outlined the factors that made it important for the railroads to span the barrier of the Rocky Mountains, and some of the steps leading up to that achievement. In the forthcoming articles I will deal specifically with the routes followed by the nine transcontinental lines which eventually laid tracks across the divide.

A Survey of the Frost-Heaving Problem

By J. O. Osterberg

Junior American Society of Civil Engineers
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Result of Differential Heave on Concrete Road
Inadequate Snow Removal Contributes to Crack Formation

Despite the great damage done to roads and other structures by frost heaving of soil, it is only in recent years that serious attention has been given to the real causes of the problem and to methods of preventing such damage. The present article is a summary of the work done by various investigators on the subject—particularly that in Sweden by Dr. Gunnar Beskow.

For many centuries the effects of winter frost on the ground and on structures has been observed, but not until recently has any explanation or experimental study been undertaken. Frost heaving, instead of being caused by the expansion of the pre-existing soil water in situ, as has been generally assumed in the past, is caused by the growth of ice, which separates from the soil in layers.

An examination of a sample of heaving ground will show that the ice appears in regular strata or lenses of varying thickness, and the total thickness of all these layers corresponds very nearly to the total frost heave. The water content is much larger than for unfrozen soil and is frequently even greater than that of soil in a saturated unfrozen condition (Fig. 1). Obviously water must be supplied to the freezing ice layers by upward flow from the ground water. Simon Johansson,[1] in 1913, was the first to explain this phenomenon, which he verified by controlled freezing experiments. Later, Stephen Taber[2] explained the mechanics of frost heaving more fully. He showed that for liquids other than water, heaving occurs upon freezing provided the soil column is able to suck up liquid from below by capillary flow.

In Sweden, the damage to roads and railroads was so serious that in 1925 a conference was held to consider the problem. As a result, the Institute of Roads and the Geological Survey jointly sponsored an extensive theorectical and experimental investigation of the problem. The results of more than ten years of work were reported in a comprehensive treatise by Dr. Gunnar Beskow[3] in 1936. In this country considerable work has been done by Stephen Taber,[2,4] A. Casagrande,[5] and others.

Various soils freeze differently, depending mainly upon grain size. Sands freeze homogeneously, causing negligible heave or none. The finer soils form ice lenses on freezing which appear in a rhythmic pattern of banding usually parallel to the ground surface. The finer the soil, the thicker and more widely spaced the lenses.

The phenomenon of ice segregation is explained physically on the basis of "adsorbed" water. Soil particles exert a molecular attraction on water molecules, the force being large close to the particles and diminishing rapidly at small distances (much less than a micron) from them. This strongly bound or "solidified" water, being under great pressure, has a low freezing point. Freezing thus starts in the center of the pores, where the water is under least pressure, and as it progresses towards the particle surfaces (where adsorption forces are greater) the resistance to freezing increases and hence the freezing point is lowered. Consequently the finer the soil is, the more difficult it is to freeze the whole mass. Tests on clays have shown that at temperatures as low as −78 C there still remain soft and unfrozen layers.

When ice crystals begin to form in the center of the void space, they press against the thin adsorbed water films surrounding the particles, but cannot "squeeze out" the water. Instead there is a transfer of molecules from the films to the growing crystals. To maintain pressure equilibrium, water flows to the films from the unfrozen soil below. Thus the water is under very large tensile stress. Crystallization proceeds, pushing upward and forming an ice layer separating the soil. The ice layer grows indefinitely if just enough heat is conducted upward from below to maintain the prevailing temperature and to remove the latent heat of freezing. Ice layers may thus grow very thick. But as soon as this condition of equilibrium is disturbed, either by a change in surface temperature or by water not being supplied rapidly enough to maintain the thermal conditions, crystals begin to form lower down, at a point where the freezing point is higher. Then an ice layer grows at this new level, and the supply of water to the layer above ceases.

Because of the many factors affecting frost heave, it is difficult to set a definite boundary between soils that have absolutely no frost heave and soils that may heave. However, the effect of grain size is so marked that this factor alone can be used as a practical criterion. Capillarity, being a combined effect of grain size, shape, and size distribution, is also useful for defining a limit.

Various investigators seem to be in close agreement on the limiting grain size. Beskow,[3] on the basis of tests on pure fractions (sorted grain sizes), gives an average particle diameter of 0.1 mm as the maximum size that will permit ice segregation under any conditions. Casagrande gives the critical size as 0.02 mm for actual soils (not fractions). Taber,[2] working with ground quartz and other materials, found that at a size of about 0.07 mm, only the faintest evidence of segregation appeared under the most favorable conditions, and that for sizes smaller than 0.01 mm, ice segregation occurred readily. Of course, in natural soils containing many sizes, grain-size distribution is an important factor. Casagrande found that uniformity is very important,

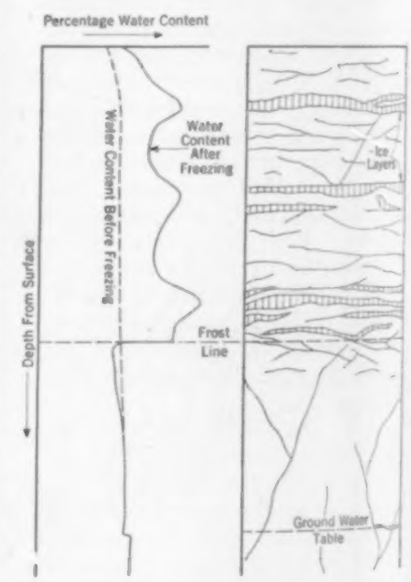


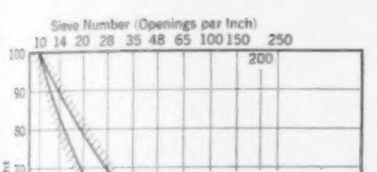
Fig. 1. Structure and Water Content of a Section of Frozen Soil

and states that for a well-graded soil only 3% of grains finer than 0.02 mm is required to produce frost heaving, while for very uniform soils at least 10% is required. The limiting grain-size curves in Fig. 2 were established by Beskow[3] from numerous tests on natural soils.

Capillarity can be determined simply by measuring the height to which water will rise above the free water surface in a tube containing the soil to be tested. For soils with large capillarities, the determination is a little more difficult.[6] The limit of capillarity between soils that do not heave under any circumstances and soils that may heave, is given[3] as $C_L = 1$ meter, and $C_D = 1^1/_4$ meters, where C_L is the capillarity for loose packing and C_D that for the densest possible packing. The limit for soils which normally do not heave is $C_L = 1.5$ meters and $C_D = 2.0$ meters.

With decreasing grain size the thickness of the adsorbed water films increases, causing more ice segregation. But when the voids become so small as to materially reduce permeability, water cannot be supplied at a sufficient rate for ice segregation, and the heave is reduced. There is then a certain optimum grain size for which frost heaving is a maximum. Very fine silts heave most; sands do not heave at all; while stiff colloidal clays have practically no heave.

Beskow[3] found empirically that the rate of heave varied inversely as the square of the pressure and inversely as the cube of the particle diameter. Here pressure is the total pressure at the frost line and is the combined effect of surface load, weight of overburden, and capillary pressure. For clays the capillary pressure is very large, and changes in surface pressure affect heaving only slightly, for the total pressure changes but little. For coarser soils, surface pressure may reduce heaving very materially. As grain size decreases, heaving increases very rapidly; but at a certain size, the capillary pressure increases greatly with decreasing grain size and the combined effect is to decrease the heave.



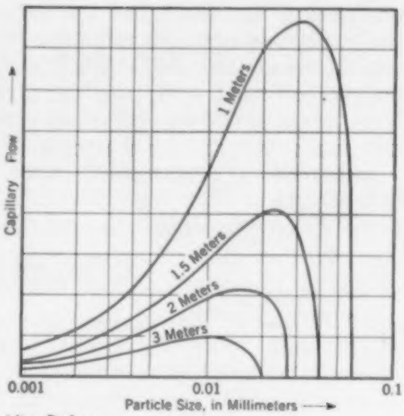
After Beskow

Fig. 2 Limiting Grain-Size Curves Between Frost-Heaving and Non-Frost-Heaving Soils

For All Material Passing No. 10 Sieve

If the depth to free ground water is greater than the capillarity of the soil, there can be no flow to the freezing layers and no heaving will occur. For coarse soils of low capillarity, heaving can be eliminated by lowering the ground water sufficiently. Even for the finer soils, the ground water need be lowered only a few feet to decrease the heave very materially. Beskow[3] has computed the maximum capillary flow that can occur for various grain sizes and ground-water depths, and his results are plotted in Fig. 3.

Dissolved substances have a marked influence on the rate of heaving. It has been shown that solutions change the ion concentration, which in turn affects the thickness of the adsorbed water films. Calcium chloride and waste sulfite leach decrease heaving rather rapidly as their concentration increases.



After Beskow

Fig. 3. Maximum Capillary Flow as a Function of Particle Size for Various Ground-Water Depths

Since roads are perhaps the structures most affected by frost damage, the following discussion will be limited to road problems, but it should be borne in mind that the same general methods can be used for any other structure. Frost damage to railroads is very important and in many cases prevention of damage is more difficult than for roads, since very little differential heaving of the rails can be tolerated.

The damage caused by heaving can occur in two principal ways: (1) by the actual heave produced, and (2) by the secondary effect of the softening of the road bed due to the thawing ice layers. Heaving itself would cause no damage if it were the same in magnitude all over, but differential heaving almost always occurs, owing to varying soil composition, varying ground-water conditions, varying depths to bedrock, varying heights of fills and depths of cuts, and other causes. The effect of differential heave is seen in Fig. 4, where the road has heaved greatly over both sides of a culvert, leaving a large depression directly over it. The obvious and simple solution is to replace some of the soil near the culvert with sand or gravel. This non-heaving material will provide a gradual transition from the areas of maximum heave to the point of no heave.

A common type of damage from differential heave is the lifting of the crown of the road. When the snow has not been completely removed but just thrown aside, covering the ditches and the sides of a road, it acts as an insulator and retards the penetration of frost. Where the road is cleared, the pavement is a good conductor and the frost penetrates much deeper, thus causing more heave in the center. It is quite common to see the slabs on concrete highways tilted, with corner breaks, and the longitudinal joints opened up. Most of the damage can be prevented by careful snow removal. The snow should be cleared from the road completely, and even from the shoulders if possible. Another procedure in snow removal which helps in preventing frost damage is to remove completely the first snowfall during the late fall cold spell. The frost can then penetrate the upper portion of the road bed rapidly, allowing the thick ice layers to grow lower down. In this location they are much less harmful than near the road surface when the spring thaw comes.

The secondary effect of softening of the road bed during thawing causes the most damage to roads. As water is released from the frozen ice layers, and is prevented temporarily from draining away by the still frozen layers beneath, the bearing capacity of the road bed is reduced and a heavy wheel may exceed this capacity and cave in. Where the ice layers are excessively thick, melting may cause "frost boils"—spots where the water content of the soil is above the liquid limit, and the soil is in a liquid, "soupy" state. Flexible pavements will yield and form holes and bumps in such ground. Rigid pavements may

bridge over the boils and soft spots, or may crack from the excessive bending moments. The curves for such conditions are several: stabilization of the road base by proper selection and grading materials, prevention of boils by replacement with other materials, effective drainage, and placement of an insulating bed.

Let us now consider places where we may expect heave in a road bed. The importance of depth to ground water has already been discussed, and it is obvious that we may

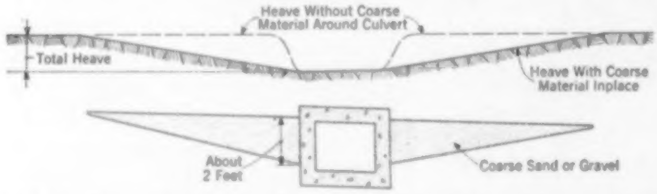


FIG. 4 DIFFERENTIAL HEAVING IN VICINITY OF CULVERT, AND REMEDY SUGGESTED

expect heave where the depth is the least. Thus in general, heaving occurs most in cuts and least in fills. On sloping ground, where there is part cut and part fill, the heave may be very large on the inner side of the road and small on the outer, causing tilting of the road bed that may even be perilous to traffic. Excessive heaving and frost boils may occur in spots where the road is quite level and does not pass through cuts or fills. At such places one usually finds that the bedrock or impermeable layer is higher than elsewhere and the ground-water surface is thus brought closer to the surface. In places of high ground water, where fills are made of heterogeneous material dumped at random, and care is not taken to eliminate dangerous frost-heaving material from the fill, large differential heaving may occur.

Practical methods of preventing damage from frost heaving are numerous and no specific rules can be given because the amount of heave, the damage experienced, and the control required vary so considerably. However, the following general methods may be considered:

1. Lowering the ground-water table.
2. Prevention of upward flow of water by a thin layer of coarse material or by an impermeable layer placed below the road bed.
3. Decreasing the depth of frost penetration by a heat-insulating material.
4. Excavating the soil completely to the total frost depth and replacing it by a non-frost-heaving soil.
5. Chemical treatment of the soil.

Of these methods, the most general and most important is the first. Drains installed to prevent or decrease heave must be placed at a sufficient depth below the road bed to keep the ground-water level at the desired elevation. Generally these subsurface drains can only be expected to decrease heave to a nominally permissible magnitude, since they cannot remove capillary water and since the capillarity of frost-heaving soils lies between 4 and 30 ft. Cases in which such drains can prevent heave entirely are those in which the soil is comparatively coarse (capillarity less than the depth of drainage) and those in which the heaving soil lies on top of a coarser material, so that the subdrain will cut down sufficiently into the coarser soil to break the capillarity. Deep drainage can be very effective on side slopes. Here the drain should be laid on the up-slope side of the road under the surface drainage ditch, where it can intercept the high ground water and lower it under the road bed to the level of the bottom of the drain (Fig. 5). Such a drain generally consists of a deep trench (6 ft or so) filled with gravel or coarse sand, with a tile drain at the bottom.

Where it is necessary to prevent heave entirely and the ground water cannot be lowered sufficiently by drainage to accomplish this, either excavation and replacement by non-frost-heaving soil or insulation must be resorted to. Excavation to the entire frost depth and placing of new material is an expensive process and may not be economical. In many cases it is cheaper to place a layer of very stiff clay underneath to prevent upward flow. Where this is done, the tight layer must absolutely never come below the ground-water table, for then it would be useless.

Heat-insulating materials have been used quite successfully in some places. Peat moss placed near the surface has been found to work well in preventing frost penetration. On slopes of cuts where mud flows caused by excessive water content may induce slides or slumping, thus blocking the road and side ditches, the formation of thick ice layers may be prevented by insulating the slope with a few feet of cinders or sodding with turf. Chemical treatment to decrease hearing has been tried with good results in some instances, but a further study and a satisfactory demonstration of the practicability of this method is still needed.

For problems in frost heaving on existing roads, any of the methods previously described may prove useful. Careful studies should be made of places causing trouble before any remedy is tried.[7,8] In many cases a trial drain, or insulating bed, or bed of coarse material demonstrates the

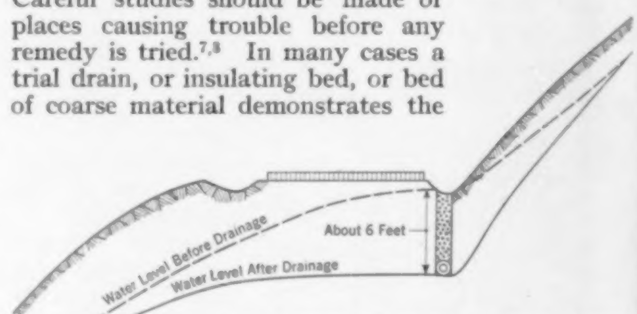


FIG. 5. DEEP DRAINAGE ON A SIDE HILL TO REDUCE HEAVING

effectiveness of each method. For new roads, a complete soil survey should be made. With proper control[9] and placement of fills and proper drainage installation, most frost heaving problems can be solved.

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Locating and Maintaining Buoys on the Great Lakes

From an Address Before the Michigan Section

By F. P. Dillon

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Commander, U.S. Coast Guard, Cleveland, Ohio

Along more than 40,000 miles of coast line and river banks of the United States, including Alaska, Hawaii, and Puerto Rico, the U.S. Coast Guard marks the waterways with buoys and other aids to navigation. Each of the 273,186 registered small-boat owners in the United States has an interest in some part of this work—and of course the needs of all of them combined are insignificant in comparison with those of commercial traffic.

All Iced Up, the Tender *Marigold* Returns from Buoy Work on Lake Superior at the Close of the Season

Responsibility of the Coast Guard for maintaining the "aids to marine navigation" dates from July 1, 1939, when under the government reorganization plan the Lighthouse Service was consolidated with it. The chief administrative officer is the Commandant of the Coast Guard, and the work is carried on by 13 district organizations, each under the supervision of a commander. Two of these districts share the work on the Great Lakes, and it is to one phase of their activities that the present article is confined.

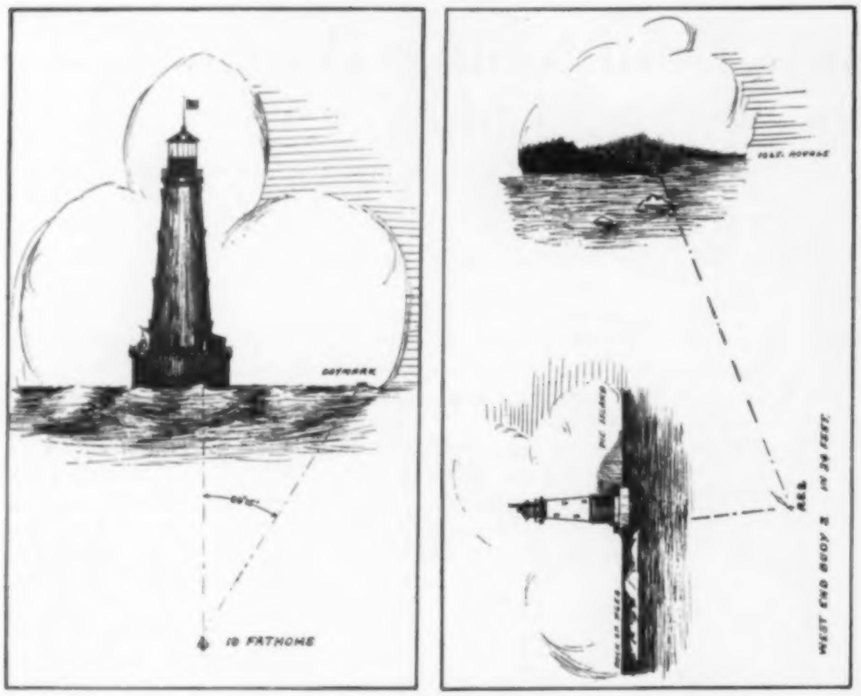
The methods used in locating and maintaining buoys on station are not well known by the public, or even by engineers in other lines. The work is done by officers of vessels or tenders which are especially designed for such operations and for other work in connection with maintenance of aids to navigation. An accompanying photograph shows the tender *Walnut*, which has its base at the Detroit depot and operates in the waters from the entrance of the Detroit River to Duluth, Minn. This tender, put in commission in September 1939, is 174 ft long, with a 32-ft beam, and has twin-screw steam propulsion with oil-burning boilers. She is capable of cutting her way through 10 in. of solid ice and has a 20-ton boom and gear. The weight of buoys to be handled on the Great Lakes does not exceed 10 tons, and on the coasts, 20 tons.

Buoy work on the Great Lakes differs from that on the southern and western coasts because of ice conditions. The season of navigation extends from about March 15 to December 15. All the lighted buoys and many of the unlighted ones are put down in the spring and taken up in the fall on account of the likelihood of damage from moving ice. The cost of a lighted buoy, with its equipment of gas tanks (or batteries) and lantern and mechanism, averages about $2,000. There is an investment of over a million dollars in this equipment in the Great Lakes area alone. The depreciation of metal buoys is negligible in fresh water, and they are withdrawn from use only because of obsolescence unless damaged or destroyed by ice or collision.

The lighted and unlighted buoys and moorings are overhauled during the winter lay-up period. Arranged in an orderly and convenient manner on the concrete dock at the depot, the empty acetylene accumulators or storage batteries are disconnected and removed by a small tractor crane for testing and recharging. The lanterns are removed for bench testing. In the spring, when all parts have been assembled and tested, and the buoys have been painted their characteristic color and given their station numbers, the tender *Walnut* starts out, as do many others, with a load of lighted buoys. A large number of lighted and unlighted buoys must be placed on station in a very limited time to mark shoals, channel limits through rock cuts, and other dangers. Visibility at this season is generally poor owing to haze and smoke. Sextant angles must be taken on shore marks to locate the station of each buoy. "Necessity is the mother of invention," and the ingenuity of the tender officer is brought into play to place the buoys in the shortest time under such unfavorable circumstances. Here is the "surveyor" hunting for a monument whose reference points have been destroyed.

On the Great Lakes, the U.S. Lake Survey provides excellent charts of the entire navigable area. These charts are used for reference by the tender officer for the

Buoys in Winter Storage on the Dock at the Detroit Coast Guard Depot



SKETCHES FROM THE NOTEBOOK OF THE MASTER OF THE *Amaranth*
Used for Relocating Buoys at the Opening of Navigation

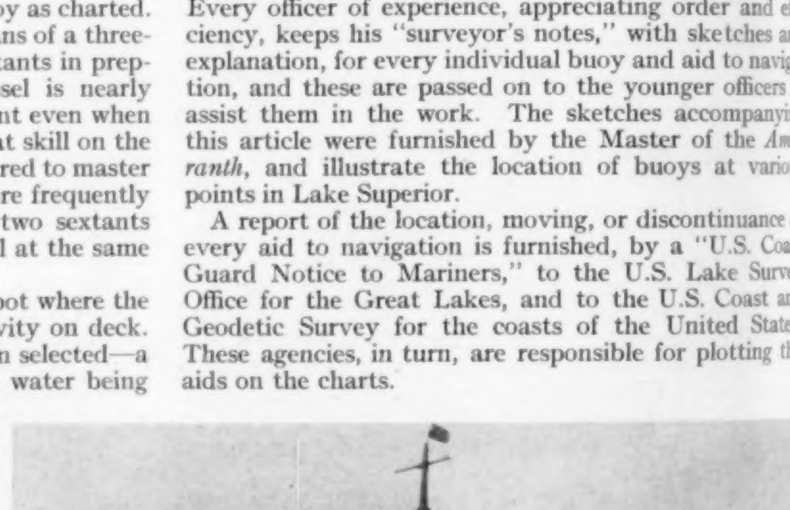
location of buoys. The physical features of the chart are so accurately plotted that the right tangent of an island, a point of land, a church tower, a smoke stack, a building on shore, or any other feature depicted can be used within range of vision of the officer with his sextant. Theoretically, two sextant angles on three selected shore points will determine the position of the buoy as charted. The angles are taken from the chart by means of a three-arm protractor and transferred to two sextants in preparation for placing the buoy. The vessel is nearly always moving on account of wind or current even when the engines are stopped, which calls for great skill on the part of the officer. Long experience is required to master the art of locating and placing buoys. More frequently than not, the experienced officer handles two sextants and gives orders for handling the engines all at the same time.

Meanwhile, as the boat approaches the spot where the buoy is to be stationed, there is great activity on deck. The proper length and size of chain has been selected—a length about three times the depth of the water being used. It is shackled to the buoy, and the concrete or cast-iron sinker, perhaps 5,000 lb in weight, is secured with split or ring keys. As the vessel approaches the station, the buoy is lowered over the side and restrained by a rope. The sinker is also lowered over the side at the buoy port and held just above the water by a separate heavy line passed through the mooring loop and taken to a bitt or cleat and secured by several turns, which may be easily and quickly released on signal. As the vessel comes to the spot guided by the officer in charge and the observed angles on the objects coincide with those on the two sextants, the attention of the crew is concentrated ready for the "let go" signal. The sinker drops on the exact spot. The buoy is lowered away and the vessel is cleared. The sinker should be placed within 25 ft or less of its theoretical position when the buoy is marking the side of a dredged channel, but never in less water than that shown on the chart or indicated on the "Light List." When conditions are especially bad, marker buoys are often put down to facilitate the work. These are recovered later if practicable.

The difficulties to be overcome in this work are many. It is done under high pressure because of the hundreds of buoys to be placed in a short time. It is not possible to pick good weather. Visibility is generally poor and the motion of the vessel often renders the handling of the buoys dangerous and difficult. The vessel is hard to control because of currents and seas, and the finest kind of seamanship is required.

The theoretical method of locating a buoy on station has already been briefly indicated. But of course the ingenuity of the officers has caused many short cuts to be devised and practical methods to be adopted. Hundreds of intersecting shore ranges of every conceivable kind have been invented using natural landmarks, all of which are the stock in trade of the capable navigator. Certain parts of the landscape are lined up and recorded for future use after the theoretical location has been accurately determined by sextant angles on a fine day for taking observations. Lacking natural ranges, target ranges may be set on shore when the tender is delivering supplies in the vicinity, and has more time for such work. Every officer of experience, appreciating order and efficiency, keeps his "surveyor's notes," with sketches and explanation, for every individual buoy and aid to navigation, and these are passed on to the younger officers to assist them in the work. The sketches accompanying this article were furnished by the Master of the *Amaranth*, and illustrate the location of buoys at various points in Lake Superior.

A report of the location, moving, or discontinuance of every aid to navigation is furnished, by a "U.S. Coast Guard Notice to Mariners," to the U.S. Lake Survey Office for the Great Lakes, and to the U.S. Coast and Geodetic Survey for the coasts of the United States. These agencies, in turn, are responsible for plotting the aids on the charts.



THE TENDER *Walnut*, WITH BUOYS ON DECK

Restoring Historic Wharf at Salem, Mass.

Civil Engineers Have Part in National Park Service Project Reviving the Memory of the Yankee Clipper Ships

By Oscar S. Bray

Associate Member American Society of Civil Engineers

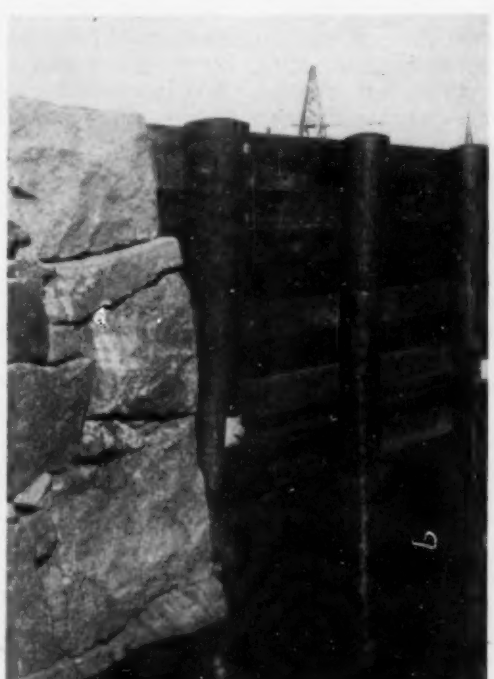
In the days when the whaling industry brought fame and fortune to New England ship captains, Derby Wharf and environs was crowded with sailing ships of all varieties. This waterfront area has now been made a National Historic Site, and the National Park Service has started its restoration. The first step in the work, the restoration of the wharf itself, has recently been completed. The procedure used, as here described by Mr. Bray, has engineering as well as historic interest.

Of the many brilliant pages contributed to American history by the New England coastal region, none is more colorful or more interesting than that portraying the early history of ships and shipping. From small beginnings in fishing voyages and the local coasting trade, there developed an industry that sent American vessels to every corner of the world. Even before the turn of the nineteenth century, while the new nation was still struggling for recognition, American ships and their trading captains were familiar visitors to the harbors of China and Japan, India, the Cape of Good Hope, Mauritius, and the East Indies as well as to those of the Continent. During the Revolution and the War of 1812, these fast-sailing vessels turned privateer and harassed the enemy's commerce, serving their nation while enriching their owners.

Immense Trade Once Flowed Through This Port

The volume and diversity of the trade developed was astonishing. Seaport towns with populations of ten thousand and less were sending a dozen ships a month to sea, to return with cargoes of coffee, spices, tea, silks, wine, hemp, hides, iron, coal, sugar, rum, and cotton cloth, part of which was consumed at home, the bulk transshipped abroad, where the shrewd Yankee merchants were taking full advantage of the troubled times. That the dollar value of the trade was commensurate with its volume is evidenced by local customs records which show duty collections as large as $100,000 on a single cargo.

Stabilization abroad following the close of the Napoleonic Wars reduced the markets available, while increasing expansion at home, stimulated in part by the capital accumulated in the shipping trade, offered new and profitable opportunities for investment. Developing manufactures, canals, railroads, and land speculation offered profit advantages over shipping and trade which could not be ignored. The money and the enterprise that made the shipping business go were gradually diverted into new channels and so this great age of American commerce passed. Little remains today save the yellowed records and the museum collections of curios, the stately houses of the merchant princes, and the ruined wharfs along the waterfronts.



Pile and Plank Bulkhead as Reconstructed; Dry Masonry Wall at Left

In order that the memory of this interesting period might be better preserved, a waterfront area in Salem, Mass., one of the important trade centers of the day, was acquired by various interested agencies and presented to the United States as a National Historic Site. The site is administered by the National Park Service of the Department of the Interior. It consists of two important late eighteenth century wharfs and certain adjoining land and buildings intimately connected with the early commercial activities carried on there. Included among the buildings is the U. S. Custom House, in which Nathaniel Hawthorne once served as Surveyor of the Port.

At the time of acquisition, late in 1937, the wharfs were dilapidated and the buildings, with the exception of the Custom House, much in need of repair. The immediate problem presented was repair or reconstruction of the wharfs, since these were subject to increasing damage with each succeeding storm.

Of the two wharfs, Derby Wharf, named after its builder and original owner, is the larger and more important. Since the restoration of the two wharfs involved similar problems, only that of Derby Wharf will be described here. This wharf consists generally of dry rubble masonry walls retaining an earth fill, and has a total length of nearly 2,200 ft with an average width of 60 ft. Records indicate that it was constructed over a period of years beginning at an unknown date prior to 1770 and continuing to 1815. Originally built along the edge of a wide mud flat, it has little or no water at low tide and approximately 9 ft at high water. The small ships of the early days were moored to the wharf at high tide and rested comfortably on the bottom at low water, an arrangement that was simple and convenient

The reconstruction problem presented was complicated by the requirement that the completed wharf be not only structurally sound, economical to construct, and low in maintenance cost, but that it be as nearly as possible an authentic restoration. Considerable historical research had already

been done by the National Park Service on the period in question, on the property itself, and on personalities intimately connected with it, prior to its acquisition by the federal government. Unfortunately, this work had

BATTERED RUBBLE WALL WITH TIMBER PLATFORM, VIEWED FROM BELOW

uncovered no information of value concerning the construction of the original wharf or the methods used, nor were any descriptions of similar wharfs available. As research continued, it became evident that wharfs as such were considered too commonplace to merit description by the historians of the time, while the builders were for the most part not given to writing. Further examination of the available documentary material proving equally fruitless, it was concluded that no information of the type sought was likely to be found. Consequently, it was decided to depend upon a thorough examination of the physical evidence available for preparation of the restoration plans and to check these where possible against early photographs and paintings, a surprising number of which came to light during the course of the investigation.

As the first step, a complete and accurate survey of the entire area was made. The survey included location of the outlines of the existing structure, street lines, property lines, buildings and utilities, as well as soundings in the slips and waterways. Maps prepared from the survey, supplemented by both aerial and surface photographs, were used as the basis for all subsequent planning work. Coincident with the survey, an examination of the existing structural parts of the wharf was made and the findings recorded. This examination was supplemented by study of the results of a similar survey which had previously been made by the City Engineer's office.

The outlines of the wharf, checked against early maps and deeds, were found to correspond closely and were accepted as correct. The outlines and general appearance of the structure being thus fixed, preparation of detailed plans was begun. Previous studies indicated that four wall types had been used—a plain gravity wall of dry rubble; a dry rubble wall to mean high tide, completed to wharf grade with wood cribbing; a pile and plank bulkhead, tied back to anchors buried in the fill; and a rubble wall with a heavily battered face overbuilt with a narrow timber platform, its inner side resting on the wall top, its outer carried by piles driven along the toe of the wall.

Foundation examination revealed that the original walls were carried for the most part on heavy timber grillages. As a matter of interest, it is noted that the white pine timbers composing the grillages were so perfectly preserved after a hundred and forty years of service that many of them were removed, resawed, kiln-dried, and fabricated into window sills and other structural parts for one of the buildings on the site.

Beneath the grillages, the subfoundation had been well compacted by its long period of loading. While it was believed that this compacted material would support a moderately increased load without serious settlement, it was decided to limit foundation pressures to approximately those produced by the original walls, or about one ton per square foot. Foundation conditions and wall sections at points at which complete or partial wall failure had occurred were given special study to ascertain the cause. In every case, it was found that failure was due to faulty construction or to insufficient cross-section and consequent lack of stability. In some cases, attempts had been made to secure stability in thin walls by building into them timber ties extending through the wall and into the supported fill. Failure at these sections occurred by overturning following destruction of the ties by marine borers or by decay, by bulging, sliding, or a combination of these.

The design for the new walls and their foundations did not deviate from accepted present-day practice, nor did that for the timber bulkhead section, save that to the normal design considerations was added the requirement that the appearance conform to that of the original. Creosoted timber and piling was used throughout because of the presence of marine borers and for protection against normal decay, these practical considerations overbalancing the lack of historical justification for its use. All timber was southern yellow pine, completely fabricated (piling excepted) before treating. Hardware, excepting spikes, cramps, and fender pile straps, was galvanized. Wrought iron was specified for the latter two items, but all other metal used was mild steel. Wall stone was locally quarried gray granite, roughly rectangular in shape and varying in size from 5 to 50 cu ft. Wide variation in shape within the limits of the specifications was encouraged to force the masons to lay the type

TIMBER PLATFORM SECTION AND, IN BACKGROUND, DRY MASONRY WALL WITH TIMBER CRIB TOP

This View Was Taken at Low Tide and Before the Basin Had Been Dredged

of wall desired. The similarity in appearance of new and old walls later justified this procedure.

Construction was carried out by day labor under the immediate direction of the National Park Service by a special organization set up for the work. The work itself presented few problems and required no unusual methods. Operations were carried out with ordinary land equipment operating from the wharf itself, the fill being built up where necessary in advance of operations.

Two methods were used in placing foundations. At those sections where complete failure of the walls had permitted the formation of wide beaches, advantage of these deposits was taken by constructing foundations in open excavation. Since the deposits did not extend to a sufficient height to protect the work beyond half tide, it was possible to work only short sections, excavating with a clamshell bucket to rough grade on one tide and cleaning up and concreting on the corresponding tide the following day. The use of transit-mixed concrete facilitated foundation construction by eliminating the normal concrete plant and its space requirements.

A Recent Aerial View of the Reconstructed Wharf

When the Restoration Has Been Completed, Buildings and Wharfs Will Constitute an Accurate Picture of This Portion of the Salem Waterfront as It Was in the Early Nineteenth Century

SHEET PILE COFFERDAMS DRIVEN WHERE THERE WAS NO PROTECTIVE BEACH

Where there was no protective beach, single-wall steel sheet-pile cofferdams were constructed. Some difficulty was experienced in driving the sheeting because of buried debris, and in such instances the area occupied by the cofferdam was dredged to clear it of obstructions. Driving then proceeded without difficulty. Joints between sheet piles were sealed with fine steam cinders, an operation that had to be repeated with each tide cycle because of the "working" of the cofferdam as the pressure varied with the tide height.

Courtesy Essex Institute, Salem, Mass.

Derby Wharf and Salem Harbor Circa 1790

From an Engraving of the Same Date Used as Part of a Membership Certificate of the Salem Marine Society, 1797

Wall stone was placed entirely by crawler crane. Each machine was equipped with a dragline fair-lead through which a line was run to the load hook to permit the operator to spot his load anywhere inside the radius of the boom head without raising or lowering the boom. This arrangement proved highly satisfactory.

Wharf fill was obtained from two sources—from a refuse fill within the limits of the area and by dredging outwash material from the adjoining dock. Dredging was handled by two cranes operating in tandem, the leading machine equipped with a dragline bucket and the follower cleaning up with a clamshell. This arrangement made it possible to dredge to proper depth from well outside the wharf wall to the wall itself, leaving the bottom nearly level and reasonably smooth.

Many interesting items were recovered during this operation, including a pre-Revolutionary English gold coin, numerous early American coins, several pieces of old hawser, and two cannon balls presumably dropped overboard during the fitting out of some privateer during the Revolution or the War of 1812.

PROJECT INCLUDES RESTORATION OF BUILDINGS

Work on buildings was carried on concurrently with that on the wharfs. Since limitations of funds did not permit of more than necessary preservation work on these structures, a complete restoration was not attempted. However, all work was kept within the framework of the general restoration plan, and upon completion of the restoration, buildings and wharfs will constitute an accurate picture of this portion of the Salem waterfront as it was in the early nineteenth century.

Work was under the direction of the National Park Service, for which O. G. Taylor, M. Am. Soc. C.E., is chief engineer, T. C. Vint, Chief of Planning, and L. M. Gray, M. Am. Soc. C.E., Regional Engineer, Region One. The writer was in direct charge of planning and construction.

The Effect of Shasta Dam on the Sacramento River

With Special Reference to Navigation and Flood Control

By F. M. S. Johnson

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Major, Corps of Engineers, U.S.A.; Assistant Division Engineer, South Pacific Division,
War Department, San Francisco, Calif.

Although the Sacramento River is potentially one of the nation's most important inland waterways, says Major Johnson, navigation on it is now largely confined to the section below the city of Sacramento. That portion from Sacramento up to Chico Landing is particularly worthy of further improvement, and when Shasta Dam is completed, it is estimated that its operation in average seasons can maintain a depth of 6 ft in that section. Another incidental benefit to be derived from Shasta Dam, principal storage unit of the Central Valley Project, will be the reduction of flood damages. In the present article Major Johnson reviews the existing projects for both flood control and navigation on the Sacramento, giving special attention in each case to the Shasta Dam effects. The views expressed here are those of the author and are not to be construed as necessarily representing the views of the U.S. Engineer Department.

Navigation on the Sacramento River, Calif., began with the discovery of gold in the tailrace of General Sutter's sawmill at Coloma in 1848. As the settlement of the valley progressed and towns were established along the streams, land travel proved too slow and difficult for the impatient multitude, and every available boat at San Francisco was pressed into service for the trip up the Sacramento River. Ocean-going steamers that came around Cape Horn to San Francisco continued on to Sacramento, about 125 miles upstream, and some even went up the Feather River as far as Marysville, 60 miles above Sacramento (Fig. 1). By the spring of forty-nine, the rush had become so great the profits to be obtained from river commerce assumed the proportion of a separate bonanza.

During the decade of 1850–1860, several companies operated year-round service between San Francisco and Sacramento. The two best-known boats drew 13 ft of water, and freight and passenger boats of lesser depth operated regularly to Marysville and Red Bluff. But within a few years, operation of the hydraulic mines of the Sierra Nevada virtually put an end to navigation above Sacramento. Hydraulic mining was begun on tributaries of the Sacramento River in 1856, and the first obstruction to navigation due to mining was noted following the unprecedented floods of 1862, which carried an enormous volume of debris from the mountains into the valley. Shoals rapidly formed, and channels were fouled and boat landings isolated by sand bars.

The millions of cubic yards of debris dumped into the streams continued to move down the river for many years after hydraulic mining was restricted by the courts in 1884. Around 1890 the controlling depth from the mouth of the river to Sacramento was but 4 ft, and from Sacramento to Colusa a little over 3 ft. Between Colusa and Red Bluff nests of snags nearly blocked the river, and above Chico Landing the controlling depth at low water was less than 1 ft.

The existing navigation project calls for a channel 10 ft deep at mean lower low water, and 150 to 200 ft wide, from the mouth to Sacramento; thence 6 ft deep at low water to Colusa; 5 ft deep at low water to Chico Landing; and such depths as may be practicable from there to Red Bluff, the head of navigation. The project depth has already been secured in the new 10-ft channel up to Sacramento, by means of wing dams supplemented by dredging, and this channel as a whole is now almost completed. Wing dams have been built and maintained at practically all shoals above Sacramento to the mouth of the Feather River, but navigation has in dry years been suspended entirely from about the middle of June to the middle of September.

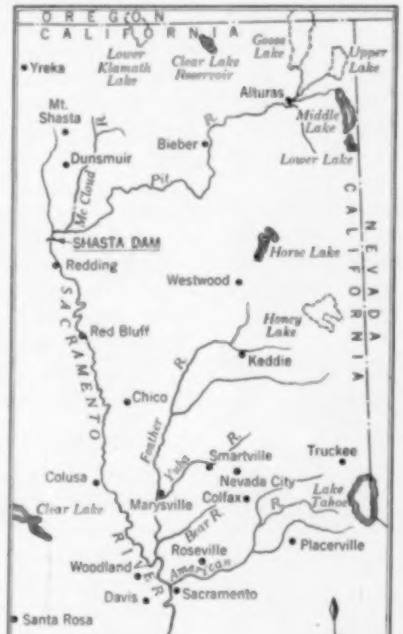

Fig. 1. Sacramento River and Tributaries

The portion of the river from Sacramento to Chico Landing is particularly worthy of further improvement, and in this connection the effects of Shasta Dam, now under construction near Redding as a major unit of the Central Valley project, are of importance. Studies indicate that Shasta Dam can be operated during average seasons to maintain a depth of 6 ft as far upstream as Chico Landing. It is believed also that some reduction in the cost of maintaining the 10-ft project depth below Sacramento will be effected.

These studies are based upon a minimum flow of 5,000 cu ft per sec provided by Shasta Dam releases. During extremely dry cycles, such as occurred from 1930 to 1935, it is doubtful if such a flow would be maintained, and traffic might be interrupted for three months each season unless the river were canalized. The canalization between Sacramento and Chico Landing (141 miles of river) would require six locks and movable dams

with lifts aggregating 112 ft in height. Lock dimensions 56 by 360 ft in the clear are considered, and the cost was estimated in 1932 to be $7,400,000, including the necessary levees and dredging. From Chico Landing to Red Bluff, the distance is 53 miles and the lift 125 ft. The cost of canalizing this section was estimated at $7,500,000.

In considering the importance of river navigation and the benefits to be derived therefrom, one should note the strategic location of the river in relation to markets and centers of trade. The valley is surrounded by mountains on all sides, which cause most of the trade to go through the seaports of the San Francisco Bay region. The Sacramento River forms a direct transportation artery to these points and passes through the main valley trading center, Sacramento. It is also to be noted that the major crops of the Sacramento Valley—rice, barley, and fruits—are shipped in large quantities from the port of San Francisco on ocean-going vessels, there being over 500,000 tons of agricultural commodities shipped from the upper Sacramento Basin each year. An improved condition of the Sacramento River would allow these products to be carried for distances up to 250 miles by water to San Francisco and delivered direct to ocean terminal facilities. Between the mouth of the river and Sacramento, excluding Rio Vista, there are 17 large wharves, 36 large warehouses, and many small warehouses and landings.

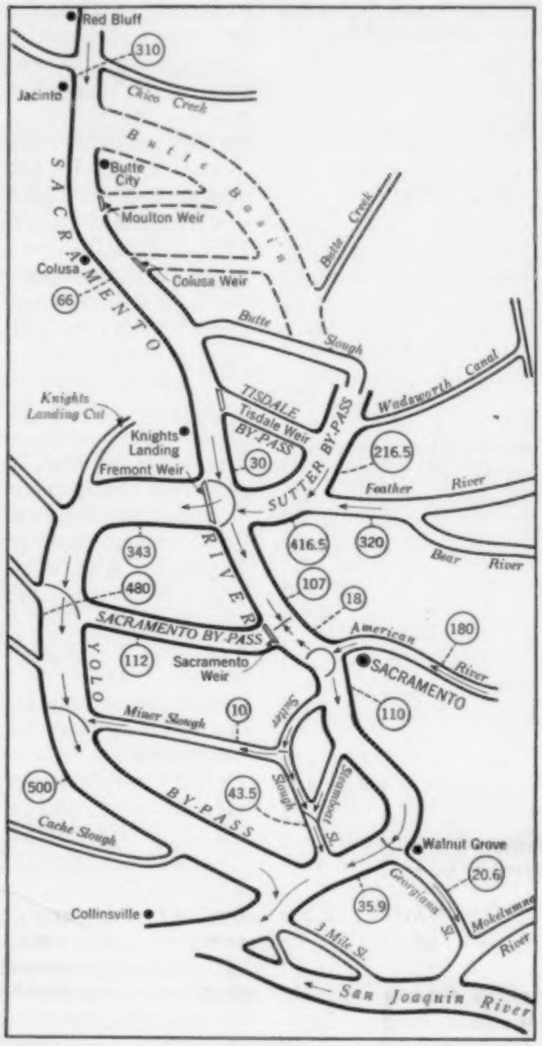

Fig. 2. Schematic Diagram of Sacramento River Flood Control Project (Not to Scale)
Figures in Circles Indicate Channel Capacities in Thousands of Cubic Feet per Second

Between Redding and the mouth of the Sacramento River there are about 3,000,000 acres of farm land in the valley floor, approximately 65% of which (including about 650,000 acres of irrigated land) is now used for crops. Agriculture, mining, and manufacturing constitute the principal income-producing activities within the Sacramento Valley. The approximate gross income from these activities for 1930 for the entire Sacramento Valley was $270,000,000. In 1930, tonnage from the tributary area moving parallel to the river above Sacramento was about 750,000 tons. With a minimum channel depth of 6 ft, as planned with Shasta Dam operating, it has been estimated that the average annual saving from navigation would be $300,000.

Although the Sacramento River today is potentially one of the nation's most important inland waterways, regular year-round navigation is still largely confined to the section of the river below Sacramento, pending further improvement in the upstream channel and seasonal regulation of river flow.

FLOODS AND FLOOD CONTROL PROJECTS

Records of floods in the Sacramento River area go back to that of 1805—an epochal event in Indian history. The flood of 1825–1826 was outstanding in the memory of the natives; and that of 1850 lived in the memory of early white settlers as a frightful visitation to the pioneer towns. The city of Sacramento was flooded in 1850, 1852–1853, and 1862. With the population of the valley constantly growing and agriculture becoming more and more its leading industry, the general and individual flood hazards continuously increased.

In 1893, by the "Caminetti Act," Congress created the California Debris Commission with authority to regulate hydraulic mining operations, improve and maintain the navigability of rivers, and prepared a flood control plan. The commission's report of 1910 proposed a plan for flood control in the Sacramento Valley essentially similar to the existing project now under construction. Its main features are shown schematically in Fig. 2. It provides for levees along the Sacramento River channel and leveed by-passes through Sutter and Yolo basins of a width sufficient for the passage of floods. Relief by-passes at various points permit water to escape from the river channel into the by-passes. When the flood discharge exceeds the normal capacity of the river along Butte Basin, water overflows into the basin through natural overflow channels at the upper end, and through Moulton Weir (500-ft crest) and Colusa Weir (1,650-ft crest) farther downstream. After making their way downtream through the fields of Butte Basin, the overflow waters are concentrated in Sutter By-Pass, which is 4,000 ft wide at the upper end, between levees 18 to 20 ft high, and has capacity of 216,000 cu ft per sec and a 5-ft freeboard. Further relief for the river is afforded by Tisdale Weir (1,155 ft crest) which has a well-leveed by-pass diverting water to Sutter By-Pass.

Below the mouth of the Feather River, the Sutter By-Pass increases in width to 7,000 ft and in capacity to 416,000 cu ft per sec. At Fremont Weir (9,120-ft crest) the excess waters cross the river channel and enter the Yolo By-Pass, which is from 8,000 to 13,000 ft wide in the portions which have levees on each side, and much wider in the lower reaches. Levees range in height from 15 to 20 ft, with a 6-ft freeboard. The capacity at the upper end is 343,000 cu ft per sec and at the lower end 500,000 cu ft per sec.

The Debris Commission's proposed plan, with minor changes, was adopted by the State of California in 1911, and by the federal government through the Flood Control Act of March 1, 1917. The project is now about 85% completed, and the total estimated cost is $51,000,000, exclusive of right of way.

The project was designed with the assumption that the area known as Butte Basin might at some future

time be reclaimed and flood waters carried through it in a leveed channel leading from a point near Butte City to the upper end of the Sutter By-Pass. For a project flood the storage capacity of the basin is estimated to be 700,000 acre-ft, which has an important effect on floods from the upper Sacramento River. About 130,000 acres in the basin could be reclaimed, but much of the land not damaged extensively by floods is now in pasture.

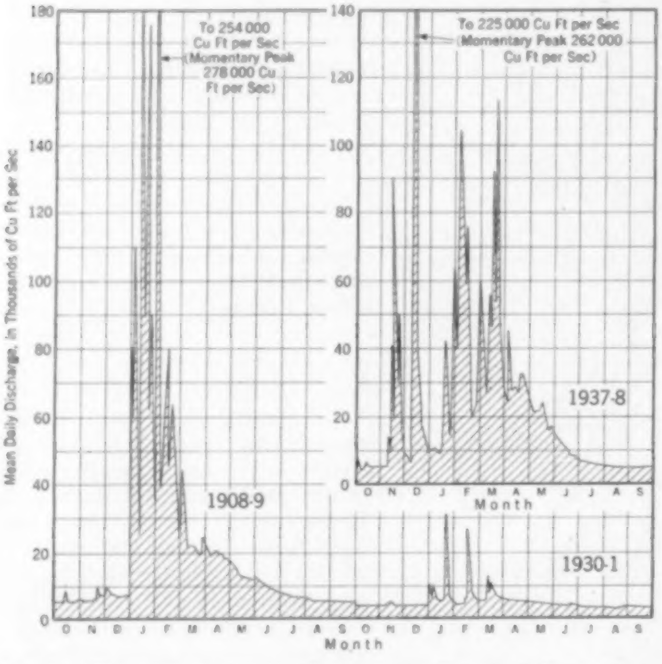

FIG. 3. HYDROGRAPHS OF THE SACRAMENTO RIVER AT RED BLUFF FOR REPRESENTATIVE YEARS

It is in this vicinity that the effects of Shasta Dam on flood control will be of particular importance. Estimates indicate that flood flows through Butte Basin will be reduced substantially by Shasta Reservoir storage, thus making it possible to confine the flow to the river as far as Colusa. In the 1937 flood, it is estimated that the damage done in Butte Basin by natural overflow amounted to $213,000. It is further estimated that this overflow reduced the flood peak by roughly 110,000 cu ft per sec. Shasta Dam could have reduced the flow by about the same amount without the aid of Butte Basin storage, and hence would give about the same degree of protection below as now exists. If the Butte Basin lands could be safely utilized for intensive farming, the flood control benefits of Shasta Dam would be greatly augmented. If the flood control project were to be utilized to capacity, it has been estimated that 500,000 acre-ft of flood control storage at Shasta would reduce flood peaks 30% or more at the head of Butte Basin.

CHARACTERISTICS OF RUNOFF AT RED BLUFF

Hydrographs shown in Fig. 3 illustrate conditions at Red Bluff for three representative years. The major portion of the runoff occurs between December and April. As most of the drainage area lies below the elevation at which snow is deposited, the runoff during the winter period is characterized by high peak flows of short duration, usually of only a few days. The snow deposited at higher elevations during the winter usually melts in April and May, and by June the river has to depend almost entirely on ground storage for its supply. Thus it can be seen why even in 1909 (one of the wettest years of record) the discharge of the upper Sacramento dropped to about 6,000 cu ft per sec, and in 1931 (an extremely dry year) to only about 3,000 cu ft per sec. Of these flows about 2,000 cu ft per sec are withdrawn for irrigation on the upper river, so that the amount of water remaining in the river between June and November is usually between 1,000 and 4,000 cu ft per sec.

The flood of 1909 closely approximates the project design storm. The second hydrograph is for 1931, a very dry year, and the third includes the flood of December 1937. This flood was typical in many respects of those of major magnitude produced by winter storms that occur in the Sacramento Valley, and since it was of recent occurrence, more data are available concerning it than for previous floods. On the morning of December 10, 1937, the weather map showed a storm of record magnitude and almost hurricane intensity off the coast of Washington and Oregon. In the two-day period, December 10 and 11, rainfall in excess of 18 in. fell in places. The greatest 24-hour fall reported was $11^1/_2$ in.

About 48 hours after the beginning of the rain, the flood waters had practically reached the Sacramento River, and a flood wave began moving down that stream which crested at Shasta Dam at 2:00 a.m., December 11, 1937; at Red Bluff at 8:35 a.m.; and at Sidds Landing at 5:00 p.m. the same day, where it totaled 310,000 cu ft per sec. The crest reached Butte City at 7:30 a.m. on December 12, and arrived at the Fremont Weir from both the Sacramento and the Sutter By-Pass at 4:25 a.m., December 14.

The Feather River crest had passed Fremont Weir on December 12, and on the American River the flood crest had gone by Sacramento ahead of the up-river crests. This was a fortunate condition, for while Sacramento and adjacent communities appear to be adequately protected by the existing project works against floods such as have occurred in the past, a simultaneous cresting of the largest discharges would certainly tax to the utmost the present capacities of the project protection works. Within the city limits of Sacramento most of the area is below the levees, and in the event that these failed the city would be submerged to a depth of from 11 to 15 ft.

Expressed in monetary values, the physical damage that could result from a major flood causing inundation of rural areas within the existing project protection works, and at the same time flooding the cities of Sacramento and North Sacramento, is estimated to be $47,000,000.

BENEFITS TO BE DERIVED FROM THE OPERATION OF SHASTA DAM

Operation of Shasta Dam would in most floods take the place of the work now being done by Butte Basin, but in extreme floods both reservoirs would be used to capacity, giving increased flood protection to downstream points. The benefit from Shasta Dam at points below Butte Basin, with the basin operating as at present, is insignificant except in extreme cases, of a frequency of about once in 100 years, in which it might result in eliminating flood damage amounting to millions of dollars caused by levee failures or overtopping.

By remedying the intrusion of salt water into the delta of the Sacramento and San Joaquin rivers, Shasta Dam eliminates from consideration federal participation in the construction and operation, at great cost, of locks and structures to prevent such intrusion. Taking into account this item as well as the direct benefits to navigation and flood control on the Sacramento River, general and federal benefits from the construction of Shasta Dam warrant a special direct participation by the War Department of $12,000,000 in the cost of the structure.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

TVA Studies Questioned and Defended

To the Editor: In the October issue, page 622, T. B. Parker makes certain statements involving my name and concerning engineering work done by me on a proposed system of flood control in the Tennessee Valley. This work formed the basis of my testimony in December 1937 before a three-judge federal court at Chattanooga, Tenn.

He states that my estimate of cost "of $81,000,000 for a single-purpose flood control system" of dams and reservoirs on tributaries of the Tennessee River (the so-called Kurtz plan) has "been shown to be entirely inadequate, probably not more than half of the proper figures," and "considerably less than the costs estimated by army engineers for the same sites." So far as I can ascertain Mr. Parker has never made public any engineering data to support this statement. On December 3, 1938, as a witness before a Joint Committee of Congress he referred to the "grossly underestimated cost in this proposed so-called Kurtz system for flood control," but his only evidence in support of that characterization is quoted herewith in full as follows:

"Now, if the reservoirs, however, were completed as proposed, the cost would be very materially in excess of this $81,000,000, as is evidenced by an examination of estimates for similar reservoirs made by the Corps of Engineers, and recorded in House Document 259, recently referred to; and also in House Document 328. These estimates of the army engineers cover all but about four of the reservoirs proposed. Taking the assumed estimates and combining them with the estimates of the TVA engineers on these remaining four reservoirs, we obtain a total of between $140,000,000, and $150,000,000, as compared with the $81,000,000 given by Kurtz."

It should be noted that all the estimates in House Document 328 are army engineers' estimates based on combined power, navigation, and flood control and thus do not apply to my single-purpose flood control project. And House Document 259, prepared by the Mississippi River Commission, discloses no engineering data as to the designs and no details of the estimates, other than the totals for three major items of each project, denoted as "construction," "flowage," and "railroad, highway, and other damages."

Upon such so-called "evidence," Mr. Parker has presumed to discredit my estimate, which was based upon specific and detailed designs prepared by me for 18 of the total 19 dams comprising my single-purpose flood control project. My figures were also based upon actual contract unit prices for a similar single-purpose flood control system constructed under army engineer designs and supervision. My estimates required the services of 12 engineers as well as my own practically undivided attention over a period of $3^1/_2$ months. Mr. Parker, on the other hand, relied on estimates made by TVA engineers for only 4 of the 19 dams of my project. For the remaining 15 dams he merely "examined" the work of others and took what he calls "the assumed estimates" for those 15 dams.

Further, Mr. Parker characterizes my estimate as a "claim," "typical" of "adverse statements and charges made in the course of recent controversies which have been of a political rather than an engineering character." This is so worded that it casts opprobrium upon my reputation as an engineer, and even impugns my motives in exercising a professional right to express myself on a technical subject.

Ford Kurtz, M. Am. Soc. C.E.

New York, N.Y.

To the Editor: My discussion of the construction program of the Tennessee Valley Authority as presented at the Chattanooga Meeting and published in abridged form in the June 1939 issue of Civil Engineering consisted of a brief account of the general objectives, administrative features of engineering organization, and accomplishments to date of the TVA. No reference was made to the political and engineering controversies with which the TVA has had to contend since its inception, nor were any personal remarks included. In the discussion of my paper, however, the Kurtz Flood Control Plan was mentioned, along with several other controversial features, and it seemed necessary that I make a specific reply to certain statements which to me appeared inaccurate.

The flood control plan advocated by Mr. Kurtz consisted of 19 single-purpose flood control dams on various tributaries of the Tennessee River. Fourteen of these were identical in storage capacity with those proposed by the Corps of Engineers in House Document 328, and comparable estimates of the others were made from data available in TVA files. The TVA did not make estimates of cost for all the sites suggested by Mr. Kurtz, since construction of these dams is not proposed, and the army estimates appeared adequate. The army estimates showed separately the cost of dam, reservoir, navigation facilities, and power plant. In comparing the army estimates with those presented before the Joint Committee of Congress by Mr. Kurtz, the figures given by the army engineers for the cost of dam and reservoir only were included, with cost of navigation features and power plant deducted.

The total cost of the 19 reservoirs as computed largely from these army estimates was in round numbers $146,000,000, as compared with Mr. Kurtz' estimate of $81,000,000. Comparison with costs of projects since constructed indicates that the army estimates in H. D. 328 may be considered to be fairly indicative of actual cost and certainly not twice too high.

Foundation conditions for dams in this region are very uncertain. Estimates made without benefit of foundation drilling are at best indicative only and should, if possible, be reviewed in the light of experience gained in actual design and construction of dams in the region.

As Mr. Kurtz states, the estimates of H. D. 259, prepared by the Mississippi River Commission for single-purpose flood control dams, are not in detail. However, the volume of storage and estimated cost of each reservoir in this report agree fairly well with the estimates for the same sites given in H. D. 328 after deducting navigation and power costs.

The foregoing is not an argument but a statement of fact. There is no intention to reflect upon Mr. Kurtz' integrity or reputation, and certainly no desire to discuss the issue further than is necessary to answer criticism.

T. B. Parker, M. Am. Soc. C.E.
Chief Engineer, Tennessee Valley Authority

Knoxville, Tenn.

[*Note:* Discussion of the paper by Mr. Parker, previously closed with the October 1939 issue, has been reopened by the Committee on Publications for the single purpose of accommodating this discussion and author's final rejoinder. *Editor.*]

Flood Flow Data

Dear Sir: In his article on "Possible and Probable Future Floods," in the November issue, William P. Creager has done a real service in bringing together and reviewing our ideas of maximum flood flow as they have been changing since 1890. However, in his interpretation of the data which he presents, Mr. Creager makes the following statement: "There is no evidence that climatological conditions are changing perceptibly, the upward trend of the curves . . . being due solely to an increasing number of gaging stations and an increasing period of record."

The writer agrees thoroughly with Mr. Creager's major objective behind this article—namely, that there must be a great many spillways in this country of inadequate capacity and, therefore, a great many unsafe structures. He agrees with him, also, that the evidence of climatological change, if any, is slight.

He believes, however, that Mr. Creager has completely ignored the fact that the whole water flow regime of the drainage basins of the United States has been steadily and progressively altered as

the result of our occupation and development of the areas, that this fact has been particularly marked since 1890, and that the change is still going on.

There is good evidence that our occupancy and use of the land, particularly in the Mississippi Valley and Great Plains regions, have resulted in reduced values of infiltration rates for great parts of these areas as they are active during precipitation periods, and that, in consequence, greater proportions of the rainfall are appearing as runoff. This, however, is probably not the most serious change in regime, the more important increase in flood flow in the streams actually resulting from the introduction of conditions which facilitate and speed up the concentration of runoff to and along stream channels.

Probably the most important changes of the land surface with respect to the facilitation of runoff have resulted from the introduction of land drainage, from the extensive development of gullies, and from the increasing network of highways with the very excellent drainage that is being provided for them. The result of these three operations has been to permit excess rainfall on the land to arrive at stream channels not in increased volume, but at greatly increased rates.

In addition to these changes which have increased the rate of flood flow into the valleys of the major streams, there have been major changes in the streams themselves—at least in streams in alluvial valleys. As an example of this, at a recent public hearing in the Southwest, it was stated that between two points on the Canadian River, the river mileage at the time of settlement was 170, the channel width from bank to bank about 100 ft, the channel depth below ordinary bank level possibly 25 ft, and the banks and bottom lands were heavily overgrown. At the present time the river mileage between these points is approximately 40, the bank-to-bank width of the channel approximately 2,000 ft, and the channel depth possibly 6 ft; the bottom lands are entirely in cultivation, and timber and undergrowth have practically disappeared. It takes very little imagination to see what such a picture means to change in flood flow. If such an alteration has occurred throughout most of the length of the Canadian River, it is easy to imagine that floods at the mouth may be occurring from much shorter and more intense storms than would have been critical to this basin in the early days.

The writer is not familiar in detail with the conditions of the Republican River valley in 1935, or of the valleys of the Texas streams in 1935, but undoubtedly the water flow regime of both of these basins had been materially altered during, say, the 25 years preceding. Even though the storms that caused these floods may have been the greatest of record, it seems reasonable that the great increase in recorded peak flows should not be chargeable solely to that fact.

Possibly the changes in land use which are responsible for the change in regime have about reached their limit, but it seems possible that the consequences of these changes in alteration of stream flow characteristics have not yet been fully realized.

If the premise which the writer has set out here is even partially correct, it would indicate the futility at this time of further studies of stream flow variation on the basis of probability of occurrence of natural phenomena alone. It would seem more reasonable to make such studies only with respect to storm potentialities and probabilities of occurrence than to attempt to evaluate flood flows in light of existing physical conditions of the drainage basins themselves.

W. W. HORNER, M. Am. Soc. C.E.
Consulting Engineer; Professor in Charge of Hydraulic Engineering, Washington University

St. Louis, Mo.

DEAR SIR: Mr. Creager's article, "Possible and Probable Future Floods," in the November issue, questions the reliability of the probability methods along the lines developed originally by the late Allen Hazen in the determination of floods for spillway design. As one who assisted in making these methods (which Mr. Creager refers to as "now obsolete") available to engineers in general, the writer submits the following comments on Mr. Creager's statements.

It is not necessary to discuss the various probability or "statistical" methods, as they have been analyzed and compared in U.S. Geological Survey *Water Supply Paper No. 771*. The important thing is that the theoretical probability formulas, such as the Pearson formulas used by the writer, or the curves proposed by R. D. Goodrich or J. J. Slade, Jr., represent mathematical procedures that may be applied to any set of statistical data. The reliability of the results so obtained depends on the accuracy and comprehensiveness of the original data. The Pearson curves, for example, have been extensively used in actuarial work and in general statistical analysis. If they are now "obsolete" in studies of hydrology, it is not due to any basic errors in the mathematical method, but rather to misapplication.

The writer has always realized the danger involved in applying such theoretical formulas to short-time records, and then attempting to estimate occurrences with a probability of once in 1,000 or 10,000 years. The weakness of such procedure has been emphasized by numerous authors. It is obviously preposterous to attempt to compute a 10,000-year flood from a 10-year record. The longer the original record, the more reliable the results will become. The mathematics, however, can only be considered a guide in interpretation of whatever data there may be at hand.

The probability methods may be applied to rainfall records as well as to stream-flow data. And since the former are generally much more extensive than the latter and often cover a considerable number of years, they may be much more suitable for such analysis. Mr. Creager gives a hint of some such procedure, when he speaks of "the probability of a storm, of greater magnitude than any that has occurred in the past, centering over a given drainage area." Probability analysis is also an important adjunct of the "rational method" of constructing a hydrograph of maximum expected flood, and should be adapted to similar use in connection with the unit-hydrograph method.

The probability methods have undoubtedly been misunderstood at times and applied to data for which they are not suited, but this does not warrant the statement that such methods have no field of application in hydrology.

Mr. Creager attempts to show in his Fig. 7 that there is a definite trend towards increasing flood maxima as the records become larger. This infers that, in each decade, there is at least one flood that is larger than in any previous decade, but this is not consistent with actual long-time records. The propriety of making an analysis of floods of the entire country, without considering the widely varying topographic and climatic conditions under which they occur, may also be questioned.

It would be very helpful, in any study of flood probabilities, if the absolute maximum possible flood at any particular site could be determined. Several of the theoretical methods provide curves which have an upper limit, and their application would be facilitated if that extreme limit could be closely estimated. Any other known hydrologic facts should also be used in connection with a probability study.

H. ALDEN FOSTER, M. Am. Soc. C.E.

New York, N.Y.

TO THE EDITOR: In response to the various comments on my paper perhaps I can clarify the issues somewhat. I am afraid that I have not made my position on probability methods quite clear to Mr. Foster. I do not question the accuracy of probability methods, provided they are based on reliable data. However, while I recognize that they are still applicable "for special cases where the frequency of smaller floods is to be studied," I consider that the longest records available in this country do not alone constitute reliable data upon which to base the determination of spillway capacity. Therefore I made no claim that the method has "no field of application in hydrology." The coefficient of variation in probability methods is also useful in comparing the flood characteristics of one stream with another.

Mr. Foster questions the use of data from the entire country in constructing my Fig. 7. I have explained that I used the entire country "in order to have the greatest possible quantity of data from which to work," and that "conclusions would be the same were any sections of the country similarly used."

I do not understand the statement regarding "at least one flood that is larger than in any previous decade." However, I did not intend any such inference, at least as applied to any one river. Mr. Foster is hopeful of determining "the maximum possible flood at any particular site." I can only wish him luck in his endeavor, since I believe this to be impossible.

Mr. Horner believes that the "whole water flow regime of the

drainage basins of the United States has been steadily and progressively altered as the result of our occupation and development of the areas." While I see distinct evidence of this in small areas, and particularly in urban areas, I have no positive evidence that this has materially affected the very large areas. However, if such is the case, it adds one more factor to the tendency for the enveloping curve of record floods to increase with time.

WILLIAM P. CREAGER, M. Am. Soc. C.E.

Buffalo, N.Y.

Railroad Problem Reflects General Conditions

TO THE EDITOR: Colonel Wilgus' article on "Nationalization of the Railroads?" in the October issue, is very interesting and scholarly, but I believe the plight of the railroads is no worse than that of many other industries in the United States at present, and that this deplorable condition is due to the boosting of wages above their market value by monopolistic or legislative methods. When wages are again determined by the value of the production in accordance with the law of supply and demand, the railroads and other industries will be able to operate at a profit, and there is nothing else that will make this possible. If Group A of the producers demands, in exchange for its product, double what Group B is able to produce, only one-half of this product can be sold. Therefore Group A will receive no more than if it had sold all of its production for what Group B had to offer (the market price); in the latter case the total production would be $33^1/_3\%$ greater.

Organized labor in the building trades, coal mining, railways, merchant marine, and other industries is demanding in exchange for its services more than the balance of the people are able to produce. Therefore the government is forced to borrow huge sums of money to make up a part of this shortage of buying power, and there are still 11 million unemployed because no profit can be made by their employment. The political power of labor has become so great that compensation for services is being determined by law and union rules instead of by the value of the production. This will destroy the efficiency and initiative of the American workingmen, which is what has enabled them to earn higher wages than can be paid in other countries.

For the years 1930 to 1934, inclusive, the national income paid out exceeded the value of income produced by 26,420 million dollars. That sum is the difference between wages paid and the value of the production. Since 1934 the government has been forced to help meet this deficit, largely by borrowing. The transportation industry paid out more than it took in for 7 out of the 9 years from 1929 to 1937, inclusive, and six of the other industries lost money in all nine years. Four out of the five public utilities in which I happened to own stock went into receivership, with a loss in the value of the stock of 237 to 1. The financial condition of the railroads, bad as it is, is not much worse than that of many other industries.

If the carpenters now idle were allowed to work for wages that a majority of the people could afford to pay, there would be no housing shortage and millions would be employed. Before the war the employee class received $55^1/_2\%$ of the national income and now this class receives $67^1/_2\%$. The buying power of annual wages of the employee class (from 30 to 40 million persons) has increased 45% since 1914, and the buying power of hourly wages received by organized labor has doubled or tripled.

It is because of the political power of the railroad unions that the railroads are forced to pay millions of dollars for services that are not rendered. Capital outlay or reorganization to save labor expense is useless when the unions are able to prevent the displacement of labor. Government ownership would make matters worse rather than better, because not only wages but rates would be regulated by politics rather than economics. Government in business on a large scale would be economically possible only if all employees of the government were deprived of the right to vote. The problem of the railways is the same as that of the nation and can be solved in the same way—restore the liberty of every man to earn as much or as little as he is capable of doing.

ARTHUR B. FOOTE, M. Am. Soc. C.E.
Consulting Mining Engineer

Grass Valley, Calif.

Simplified Design of Box Culverts

TO THE EDITOR: The article, "Simplified Design of Box Culverts by Moment Distribution," by Victor W. Sauer, which appeared in the December issue, makes certain assumptions for the solution of a single and a double box culvert. In the solution of structures it is permissible to make certain assumptions but the assumptions should be in accordance with existing conditions, and the writer does not see any fundamental reason for assuming that the downward load on the top slab is the same as the upward load on the bottom slab, and that the load is uniformly distributed on the side walls.

With a slight modification of the moment distribution method the solution for a single box culvert with a different load on the top slab from that on the bottom slab, and with the side pressure varying according to a triangular loading, is accomplished in a very short time. For the double box culvert the modification will not apply, but even then the moment distribution will solve the double box culvert in a few minutes, if the proper loading condition is used.

As an example, take a single box culvert as shown in Fig. 1.

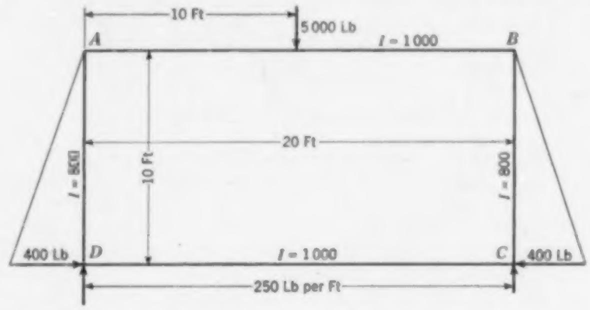

FIG. 1. CULVERT LOADING FOR TYPICAL EXAMPLE

The frame is considered as having no weight, and the length is 1 ft. The relative stiffness factor of the top and bottom slab = 1,000/20 = 50, and to shorten the moment distribution method multiply this stiffness factor by $^1/_2$, making it 25. This slight modification is theoretically correct for the above symmetrical structure and for symmetrical loading about the center line for the top and bottom slab, but the loading on the top and bottom slabs

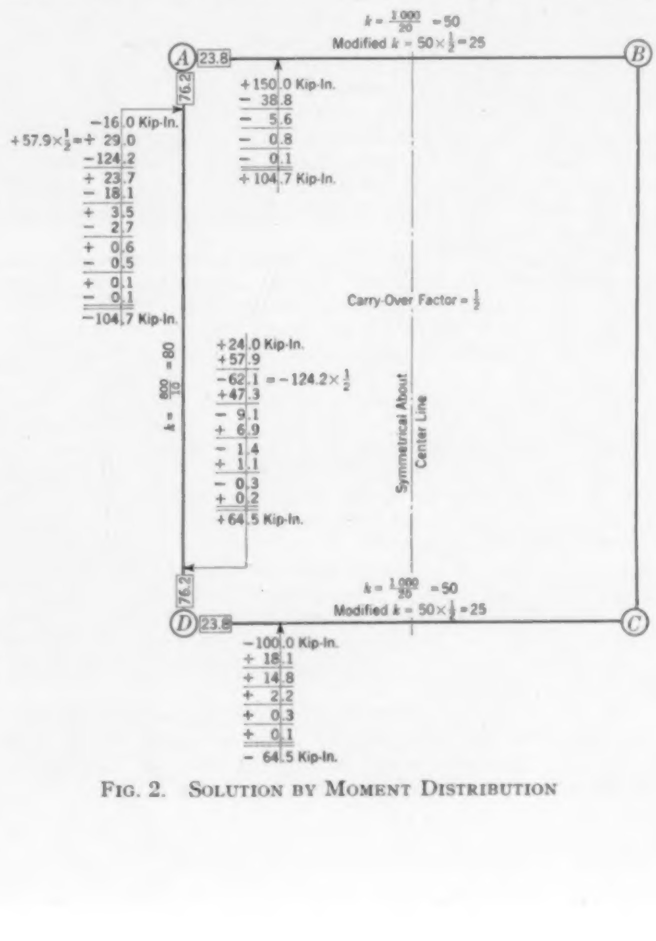

FIG. 2. SOLUTION BY MOMENT DISTRIBUTION

need not be equal just as long as the load is symmetrical for the particular span. The stiffness factor for the side walls = 800/10 = 80.

Figure 2 gives a line diagram showing that the fixed end moments $M^F{}_{AB} = +150.0$ kip-in., $M^F{}_{AD} = -16.0$ kip-in., $M^F{}_{DA} = +24.0$ kip-in., and $M^F{}_{DC} = -100.0$ kip-in. (Moments tending to rotate a joint clockwise are considered positive.)

At points D and A are shown the distribution percentages which for $DC = \frac{25}{80 + 25} = 23.8\% = AB$ and for $DA = \frac{80}{80 + 25} = 76.2\% = AD$. The carry-over factor is $1/2$, for all members are considered as having a constant moment of inertia for the entire length. On account of the slight modification of multiplying the k factors of members AB and DC by $1/2$ there will be no carry-over moments in spans AB and DC, and the carry-over moments are only required in span AD. Starting at joint D, Fig. 2 gives all the balancing moments and carry-over moments, and the final moments $M_{AB} = +104.7$ kip-in. and $M_{DC} = -64.5$ kip-in. The final moments by the slope deflection method are $M_{AB} = -104.6$ kip-in. and $DC = +64.4$ kip-in.

A. W. FISCHER
Construction Service Veterans Administration

Washington, D.C.

Status or Prestige

TO THE EDITOR: Over a considerable period of years many articles have appeared on the general subject of professional status. Two points are noticeable in connection with these articles—their number has been increasing steadily in the last few years, and the reasons offered by the writers for unsatisfactory status are seldom, if ever, in accord.

That the standing of the profession in public esteem is unsatisfactory seems the only point of unanimity. Nor has there been apparent recognition of the fact that public, or common, knowledge of the engineer's work, approval of his attitude, and respect for his judgment have improved at least a little in the course of those years. The reasons offered for this condition cover a wide range and reflect a wide divergence of opinion as to what constitutes the desiderata that serve to make up "status."

In considering our own case let us eliminate what might be classed as the "talking professions" (theology and teaching) and include only the other "working professions" (law and medicine). This is without reference to whether or not Webster includes us in the definition of "professions," meaning of course learned professions in contradistinction to the generic term "profession" as applied to any vocation.

The observation has been made that the engineer is less well known in his community and takes a less active part in community affairs than the lawyer or physician. This is quite true, and the reasons for it are obvious. It is, for instance, an integral part of the physician's building up of his personal position to "mix, get acquainted, join the clubs."

The engineer, on the other hand, barely becomes established in one locality when his work there is done and he moves on. Even if he is the "head" with an office and permanent residence back in the home town, his case is not much better as he is away so much it is impossible to maintain the close touch with his neighbors on which social and political influence so much depend. Another reason offered is that he so frequently works on a salary that he must consequently be subordinate to others. The obvious superficial answer to this is, "so does a judge, so does a mayor."

While is is true that the majority of salaried jobs are subordinate, it is not the payment of salary, per se, that makes them so. In industry a directorship more frequently means direct representation of a certain block of stock, and in public work a commissionership more frequently means the payment of a political debt than, in either case, any attempt to apply special knowledge to a specific task. For this reason we frequently see lawyers or editors at the head of government commissions and lawyers or bankers on the directorate of enterprises, concerning which they have but superficial, if any, knowledge.

All these factors have undoubted weight, but are not the basic fact underlying our unsatisfactory niche in society, which occasioned Dr. Morgan's recent observation that the engineer in private practice is a rapidly disappearing species.

In the beginning the engineer was promoter, financier, designer, builder, and probably operator, all in one. Through gradual evolution, hastened perhaps by specialization, he has become merely the designer of another's project, financed by a second, and executed by a third. Thus he is only one link in a chain. And so, having surrendered two-thirds of his function, he has left the determination as to when, how, and under what conditions his technique shall be applied, to groups with less comprehensive knowledge than his own.

C.C. MUHS, M. Am. Soc. C.E.

Chicago, Ill.

Pitot's Place in Engineering Hydraulics

TO THE EDITOR: It is a great satisfaction to those who are interested in the history of engineering to know that Professor Kirby's painstaking and patient efforts have led to the discovery of a portrait of Henri Pitot (see his article in the December issue).

Pitot was one of the first to question the theoretical conclusions of some of the scientific workers of his day in the field of liquid flow, and to advocate and undertake experimental investigations of flow under the conditions of engineering practice. He thus pioneered in a movement which led to the development of an age of empirical hydraulics to which his successors in France, notably Chézy, Darcy, and Bazin, as well as some American workers such as Francis and Hamilton Smith, made notable contributions. Through the efforts of these men, the engineer was supplied with much practical, valuable, and useful data on liquid flow. They accumulated a great mass of technical information, on which the great hydraulic works of the present as well as earlier days have been based. It is only in recent years that we have begun to bridge the gap between the empirical hydraulics of the engineer and the theoretical hydrodynamics of science. For two centuries the practical hydraulics which Pitot did so much to establish was the sole source of information available to the engineer in answering, not exactly but effectively, the ever-pressing problems of hydraulic design.

One small item in Professor Kirby's paper requires a bit of modification. The statement that "Castelli was the first to reason clearly that velocity multiplied by cross-section gives quantity of flow" may be technically correct, but there is a remarkable, very early pronouncement of Hiero's on this point which is of interest. Hiero was active sometime around 200 B.C. to the beginning of the Christian era, though the exact date is not known. In Section XXI of his "Dioptra," he discusses the measurement of the flow of a spring. After describing seasonal variations in flow as due to variations in rainfall in the mountains, the source of the supply, he then states that the spring must be walled up all around and a square pipe built into this wall through which the water is thus forced to flow. If the depth of flow is 2 digits and the breadth of the pipe 6 digits, the flow is said to be 12 digits.

This is in absolute agreement with Roman practice which measured flow by cross-section, as was the practice in ancient times —that is, they failed to appreciate the effect of velocity. Not so with Hiero. He goes on to say that to know properly the yield of the spring, we must know not only the area but also the velocity. He states that we must build a reservoir below the spring and measure the volume of water that collects in a certain period of time, which is to be noted by a sun-dial. From this measurement we may estimate the total flow for a day and, furthermore, if this second method is used, the size of the pipe which conducts the water from the spring is unimportant.

Unfortunately, Hiero's reasoning was ignored or lost sight of, and had to be rediscovered by Castelli after the lapse of some fifteen centuries or more. Clemens Herschel in his famous translation of Frontinus tells the story of $v = \sqrt{2gh}$ and reminds us that, when the teacher writes this basic hydraulic equation on the blackboards of the world today, he should recall that it took man two thousand years of thought and study to discover and relate these three symbols. Hiero could have saved man many years of effort but, apparently, Hiero was fifteen centuries ahead of his time.

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SOCIETY AFFAIRS

Official and Semi-Official

John Philip Hogan—President for 1940

Our new President, John Philip Hogan, is a generous contribution of the Middle West to the East and to the engineering profession in general. Like many another promising young man he applied Horace Greeley's famous advice in reverse. That is, he began in Chicago, where his father was a well-known attorney, but he has spent most of his mature years and all of his professional life on the Atlantic Coast. His father, it is said, was also something of a political figure—a flair which the son is reputed to have inherited. Whether or not this is so, certain it is that he has a decided bent for getting along easily with all sorts of people.

The switch in the locale of his life work was made when he came East for his college work. From Illinois, the business and transportation center of the Middle West, to Massachusetts, the great governmental and educational cradle of the East, was quite a step. But that was not all—he came to the oldest fountainhead of science and culture of the historic Commonwealth, Harvard College. There he was graduated in arts in 1903, and in engineering a year later.

John Philip Hogan
President American Society of Civil Engineers

With this auspicious professional start, he entered energetically into his engineering work. And he has continued without fail to exhibit the same tendencies ever since. Typical of Jack Hogan is the fact, well recognized by a host of friends, that no single activity in his life has lacked this same enthusiasm. It is typical of him, a vital part of him. He works hard, and he plays hard.

For example, his friends tell of one of his first jobs, when he was fresh from college. He was working far up state in New York, on a preliminary survey for the Catskill Aqueduct. In charge of a field party, he was driving himself, and the party too, like mad, even in sub-Arctic weather. A boarding house in High Falls, Ulster County, where the ink is said to have frozen every night in the parlor, was the lodging place of most of the party, also the temporary office. Bright and early one winter morning a member of the party, in evident embarrassment, came to the Division Engineer, apparently with some sort of a complaint in his system. After considerable coaxing he divulged that "Jack's driving us like all possessed on these surveys and then keeps us up in the evening plotting them. What's more, he expects us to keep up with his 'Y.M.C.A.' the rest of the night." "What do you mean by 'Y.M.C.A.'?" "He is either taking us to parties or keeping us awake when he returns. And we even have a song 'We are—we are—Hogan's Y.M.C.A.'" Shortly the culprit himself appeared, stifling his yawn; but he was very soon his old self, extremely wide awake. His superior merely said: "Now, Jack, I don't want to censor your conduct; but don't you think your men after a hard day's work are entitled to some sleep? And, by the way, what do you do for sleep yourself?" It was never necessary to repeat the admonition. But the song continued to be sung on occasion, bringing back memories of the early days on the Catskill Aqueduct—and of Hogan's exuberance of spirit. Later he became the trusted assistant to the Division Engineer, and often took his superior's place with credit. Today they are still warm friends, and associates in Society work.

This energy Colonel Hogan carried into all his engineering work. The results are well known to most American engineers, certainly to those of the East. In succession he held positions of increasing importance in and around New York—on water supply, subways, utilities, dams and waterways, and finally at the New York World's Fair. For the past 18 years he has been associated with the firm of Parsons, Klapp, Brinckerhoff and Douglas on important engineering projects, and during the last 14 years he has been a member of the firm. His success in these varied activities is apparent from the mere statement that he served for a short while as acting deputy chief engineer of the New York Board of Water Supply, and that he acted during the entire development period of the World's Fair as its chief engineer. In all, about $100,000,000 worth of work was included in the latter job. He is now vice-president and chief engineer consultant for the fair.

His various consulting engagements read like a list of the notable engineering projects of recent years. He has served the government, the U.S. Engineer Corps, various states, power and utility companies, manufacturers, municipalities, and in fact on all varieties of technical projects. To single out one is difficult, but perhaps mention should be made of his work over a number of years as director of the New York Water Power Investigation under the late William Barclay Parsons, Hon. M. Am. Soc. C.E.

At the outbreak of the War, John Hogan was division engineer on the Catskill Aqueduct. He entered the Army in May 1917 as captain of what later became the Eleventh Engineers and served two years in France, reaching the rank of lieutenant colonel, General Staff. He rose to the position of Deputy Chief, Topographic Service, A.E.F. His especial stint was in connection with the preparation of maps. It was said that his maps were so perfect that they even showed an apple falling from a tree.

Colonel Hogan enjoys telling many stories of his wartime ex-

periences. For instance, there was the time he lay abed in the morning, but so skilfully concealed under the blankets that the orderly did not notice him. With seeming impunity, the orderly proceeded to go through all the personal belongings in the officers' quarters, even taking a "snifter." When he got through rumaging, the Colonel reminded him: "There is a box of candy you have overlooked."

How well he was able to contribute in all this work to the success of the Allied cause is illustrated by numerous citations, such as the Distinguished Service Medal, the Order of the Legion d'Honneur, the Order of the Purple Heart, and the Conspicuous Service Cross.

Characteristically, Colonel Hogan was strongly opposed to the idea of spending what he regarded as a very interesting war in an office in Chaumont. This, however, did not prevent him from doing a perfectly enormous amount of work; 14 hours a day was to him a normal stint.

During his work at Chaumont, his ebullience made him a welcome companion. He was highly successful in "calling the craft from labor to refreshments." In the organization of night revels he was occasionally handicapped by some of his fellows who felt that it was fitting to sing "Die Wacht am Rhein" and "Deutschland über alles" in the inky streets of Chaumont, on the way back to billets. He showed both tact and force as a self-appointed M.P. in controlling these disturbances. In fact one of the officers holds that throughout most of his career he has acted as a "suppressee" of disturbances rather than as an agent of authority. But he has been interested in more than conviviality. Both at Chaumont and after the Armistice he was particularly successful in keeping his colleagues, both English and French, happy. So great was his success that he could easily have run for election as a member of the municipal council at Chaumont. Happily, he displayed this same quality in his professional life. Of course he is a member of many societies, including the national groups of civil, mechanical, and electrical engineers. In the Society he has served as Director (1921–1923) and Vice-President (1934–1935).

A similar example of his wide interest and his social abilities is his early experience at High Falls on the Board of Water Supply work. The contractor's forces found difficulty in securing living quarters for the men and their families. Problems of providing schools and churches, as well as entertainment, had to be met. Such questions interested Jack Hogan and he tackled the problem with the contractors as well as with the Board. As a result a chapel was built, as well as a hall where entertainments and dances were held during the four or five years that the job lasted.

Some of his experiences were not quite so happy. Take for instance the incident that occurred at Stone Ridge, N.Y., early one summer. It was near the old stone house which after the burning of Kingston by the British became the seat of government for New York State. Automobiles were scarce in those days, so that the engineers had to hire horse-drawn buckboards. So great was the demand that the local liveryman bought unbroken horses from the West and put them to work without ceremony.

On the day in question the peace of the sleepy village was roughly broken by a terrific clatter. Onlookers were aghast to see one of these wild steeds charging down the road dragging a swaying buckboard behind. Suddenly the steed swerved and headed for a narrow opening between a tree and a fence. The horse got through successfully, but there was not room enough for the buckboard. There was a resounding crash and the terrified animal dashed on, while the driver was catapulted through the air amid a shower of broken shafts and miscellaneous debris. His friends rushed over and picked up Jack Hogan—unconscious, but not for long. Fortunately for him—and for the work—he was only slightly injured by this mishap.

No write-up of Colonel Hogan would be complete without mentioning his happy home life. He was thought to be a confirmed bachelor. For several years he and J. Waldo Smith, his chief in the Board of Water Supply, maintained bachelor's quarters together. Then the Colonel married the charming and gracious lady, now Mrs. Hogan, his equal in grace and wit. A visit to their home is a stimulating experience, as all his friends well know.

John P. Hogan has made one continuous success of his professional career, by a judicious combination of hard work, technical ability, and spontaneous sociability. These same characteristics of energy, dependability, and personality he now devotes to serving the Society in its highest office. It may be recorded in advance that his term of office will be a success.

Highlights of the Annual Report

Complete Details to Appear in the Year Book, Part II of "Proceedings" for April 1940

IT IS PROFITABLE, occasionally, to take a look backward. With that thought in mind, this report of the Board of Direction to the Society deals not so much with circumstances as for only the year 1939, just closed, as it attempts to disclose present-day circumstances in relation to those of 15 and 20 years ago. The recent 15-year period embraces two distinct experiences; a pre-depression and a post-depression experience, each 7 years long, centering about a year of readjustment, the famous "1932."

* * * *

Membership has undergone a considerable change in the 15-year period, 1932 being the first point of change. Membership on December 31, 1924, was 11,170. On December 31, 1931, it was 15,190, a net growth of about 4,000, or more than 35%, in 7 years. During the succeeding 8 years, the membership has increased only 810, a growth of only a little more than 5%.

More significant than increase in total nominal membership, however, is the change in age of the members as reflected by the number of those in the Junior and the corporate grades, respectively. On December 31, 1924, there were 736 in the Junior grade, 6.5% of the total membership. On Decemeber 31, 1939, there were 4,023 in the Junior grade; 25.1% of the total membership, 16,000. The corporate membership, moreover, on December 31, 1939 is 349 less than on December 31, 1931, notwithstanding the transfer of nearly 1,200 Juniors directly into corporate membership in the same period. A conspicuous detail in the loss in the corporate grades is observed in the annual number of deaths, an average increase of 35% in the 7 post-depression years as compared with the 7 pre-depression years.

The year 1932 is a pivotal year as in that year civil engineers had felt the effect of the depression in marked degree, an experience which was reflected in inability of members to pay the dues. That the nominal number of members does not show a considerable drop is accounted for by the fact that, by action of the Board of Direction, the dues of members of long standing were canceled when it was evidenced that there was inability to pay. It was

GROWTH OF MEMBERSHIP

deemed that the interest of these members in the Society and their contributions as members of Society or Local Section committees; in the preparation of technical reports; in the writing of papers and in loyalty to the Society, was adequate offset against the loss in revenue. More than a quarter of a million dollars income was thus relinquished that the Society's organization might not be seriously impaired.

In 1925 the Society owed $200,000 and had but relatively little accumulated funds or available equities wherewith to defray that obligation. In that year a current expense was the payment of $9,000 in interest on the mortgage on its 57th Street property. Today that mortgage has been paid off and the Society has property which rendered an income, in 1939, of approximately $65,000.

The change is due primarily to two circumstances. In that pre-depression period of 7 years, the Society grew rapidly in membership, with increasing gross income from dues and initiation fees. The principal circumstance which led to an improved financial condition, however, was the rental of the Society's property on 57th Street. By the terms of a new lease of that property, net income from that source was increased approximately $30,000 per year.

Two major trends are to be noted as progressive throughout the entire 15-year period—less per capita dues and more per capita service to members.

* * * *

In a review of the Society's efforts to render an expansion of service to its members, a period of 20 years, beginning January 1, 1920, affords a clearer view than does the 15-year period used to demonstrate membership and financial changes

On January 1, 1920, the Society had a membership of 9,408. It recognized 23 Local Sections. It had no Student Chapters. There were no Technical Divisions. Total expenditures in that year were $216,531, and the net cost of its publications, $45,309. Total pages were 3,067. It held only one meeting outside of New York. Total registration at the Annual Meeting was 923.

Twenty years later, December 31, 1939, membership totaled 16,000. Now there are 63 Local Sections, 120 Student Chapters, and 12 Technical Divisions. Total expenditures in 1939 for current operations were $391,172. The net cost of publications was $72,717. Total pages were 5,840. Commonly, three Society meetings are held now, annually, outside of New York, although in 1939 the proposed British American Congress had to be canceled. Registered attendance at the 1939 Annual Meeting was 2,480.

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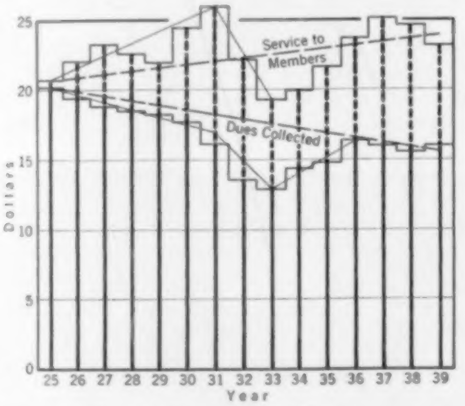
In the pivotal year, 1932, dues collected were 18.7% less than in the peak year, 1930. A survey made by the Society's Committee on Salaries indicated some 45,000 to 50,000 civil engineers



Relation of per Capita Service to Members to per Capita Dues Collected

and engineering assistants to be out of employment and the total income of the profession reduced probably 60%. The dues of 2,033 members of the Society were canceled as for that year alone. Agencies for the registration and placement of unemployed engineers were established by many of the Local Sections. Adopting a resolution, called the "Normal Program for Public Works Construction to Stimulate Trade Recovery and Revive Employment," the Board of Direction established a Committee on Public Works which it sent to Washington to be influential in the Congress and with departmental administrators. This was not the first move made in behalf of the reemployment of civil engineers, the first being in October 1931, when a committee called upon President Hoover to suggest the establishment of an expanded mapping program. Nor was it the last.

The post-depression period of the seven years 1933 to 1939, continued the efforts of the Committee on Public Works, addressed more particularly towards the operations of the Reconstruction Finance Corporation and the authorization of the Public Works Administration, agencies whereby federal credit was extended for worth-while public works construction. The Society's officers supplemented this work by assisting actively in the organization of the Public Works Administration, the Civil Works Administration and the expanded program of the U.S. Coast and Geodetic Survey.

This entire post-depression period, while characterized chiefly by an intensification of efforts to improve the economic condition of civil engineers, has had its full share of expansion in its technical services. More Technical Divisions have been formed. Committees at work under the supervision of these Technical Divisions now number 74. It is estimated that 1,460 members of the Society are now aiding, in one phase or another, in the technical work of the Society.

The Local Sections have been stimulated by increased financial assistance. Every member resident in the United States now belongs to a Section and more than 6,000 are subscribing or supporting members of Section activities. Direct financial support by the Society, together with local dues collected, enable Local Sections to expend more than $30,000 in 1939 in carrying out their work.

* * * *

Fundamentals seemingly capable of observation at this time are that the Society is in sound financial condition; its property well invested. Increased income, to permit of wider expansion of activities, seems now to be forthcoming from only increased corporate membership, more especially in the Associate Member grade. That there are many men, fully qualified for the corporate grade, has been demonstrated by surveys made recently. Activities are widely varied from highly technical, begun 87 years ago and now better than ever, to sincere and substantial efforts, more recently inaugurated, to improve the interrelationship of the civil engineer and the public. Improvement of the economic welfare of the profession seems to rest on the basis of centrally developed policies established as a guide to individual and local collective effort.

Intensive development of professionalism, in both its ideal and practical applications seems now to be the immediately desirable further expansion of the Society's efforts in its service to members.

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The Employment Service has offices in New York, N.Y.; Chicago, Ill.; and San Francisco, Calif. The number of men placed during 1939 has averaged about 86 per month.

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Summary of Publications for 1939

	Issues	Average Edition	Total Pages	Cuts	Plates
Proceedings (monthly numbers)	10	16,430	1,856	468	..
Civil Engineering (monthly numbers)	12	16,675	1,150	781	..
Transactions, Vol. 104	1	15,630	2,112	447	..
Manuals, Nos. 16, 17	2	16,100	124	26	..
Year Book	1	16,942	560	5	..
Aims and Activities	1	8,219	38	33	2
	27	....	5,840	1,760	2

* * * *

The attendance at the Reading Room during the year was 1,996. Two hundred and sixty-four periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and daily newspapers.

* * * *

Membership of Technical Divisions

City Planning	659
Construction	3,118
Engineering Economics	823
Highways	1,409
Hydraulics	2,001
Irrigation	541
Power	717
Sanitary Engineering	1,241
Soil Mechanics and Foundations	1,538
Structural	2,632
Surveying and Mapping	978
Waterways	685
Total	16,342

* * * *

There are at present 120 Student Chapters, two new ones having been added during 1939—at Northwestern University and Armour Institute of Technology, the latter being the revival of a previous Chapter that was active in 1925 and 1926.

Brief Review of the 87th Annual Meeting

Series of Events, Wednesday Through Saturday, January 17–20, 1940, Proves Most Successful

NEITHER snow squalls nor the coldest spell of winter up to that time was able to dampen the enthusiasm of the large gathering assembled for the Annual Meeting. As a matter of fact, these brief inclemencies only served to emphasize the fine winter days with which they were interspersed. From far and near members of the Society and their guests gathered on January 17, 1940, for the four-day session of the Eighty-Seventh Annual Meeting. In all, about 1,900 participated in one or more of the events on the program.

In accordance with time-honored custom, the program of the opening session on Wednesday morning centered about the conferring of honorary memberships and prizes. Four of the five newly elected Honorary Members received their certificates in person—Herbert S. Crocker, J. M. R. Fairbairn, Henry S. Jacoby, and Thomas U. Taylor. The fifth recipient, William James Eames Binnie, lives in England and was unable to be present. It was announced that Mr. Binnie would probably receive his certificate later at the hands of the American Ambassador in London.

COLONEL SAWYER PRESENTS CERTIFICATES TO FOUR NEW HONORARY MEMBERS
Left to Right: H. S. Crocker, H. S. Jacoby, J. M. R. Fairbairn, T. U. Taylor, D. H. Sawyer

Six winners of Society prizes were present to receive their awards: C. A. Mockmore, the J. James R. Croes Medal; Stanley M. Dore, the James Laurie Prize; Rufus W. Putnam, the Arthur M. Wellington Prize; Benjamin K. Hough, Jr., the Collingwood Prize for Juniors; Howard L. King, the Construction-Engineering Prize; and Albert J. Schafmayer, the Rudolph Hering Medal. Eugene L. Grant, Member of the Society, and son of the late B. E. Grant, co-winner of the Rudolph Hering Medal, had come from California to receive his father's posthumous award. Director T. E. Stanton, Jr., represented Charles H. Lee, winner of the Norman Medal, who was unable to be present on this occasion.

Reports of the Board, the Secretary, and the Treasurer, and a brief business meeting were also a part of the morning session, which was brought to a close with the enthusiastic introduction of the President-elect and the other new officers. President D. H. Sawyer completed a morning of efficient conduct of the meeting by a gracious presentation of his successor, Col. John P. Hogan. Immediately the roles were reversed, and Colonel Hogan in fitting words proceeded to bestow upon the retiring President the presiding officer's gavel, suitably inscribed, as a lasting memento of his successful year's labors.

Luncheon, served in the Engineering Societies Building, was a popular event as usual. In fact, so interested were the many members that they were loath to surrender the room for the technical sessions which were to follow immediately, conducted by the Soil Mechanics and Foundations and the Sanitary Engineering Divisions. Meanwhile, the general Society meeting was getting under way in the large auditorium. This consisted of a talk on "The Standards of Professional Relations and Conduct," given by

BEEFSTEAK SUPPER AND SMOKER AT MECCA TEMPLE, A FEATURE

Daniel W. Mead, Past-President and Honorary Member of the Society. Following an interesting general discussion, Frank Griffin, chairman of the Metropolitan Conference of Student Chapters, took over the conduct of the meeting. This Student Chapter Conference had as its primary subject a discussion of "The Social Status of the Engineer." The meeting was well handled and enthusiastically received by the many students in attendance.

As to the two other meetings held at the same time, soil mechanics in relation to the building of the New York World's Fair, and the foundations for the Mississippi River bridge at New Orleans, were the principal subjects of discussion in one session, while the other was devoted largely to the presentation of progress reports of the various committees of the Sanitary Engineering Division.

As usual, the banner social event of the Annual Meeting was the formal dinner dance held at the Waldorf-Astoria that same evening, Wednesday. A reception for the incoming President and the Honorary Members constituted an interesting part of the program. A judicious combination of good food, excellent music, and dancing served to make the evening a memorable one. Long to be remembered were the many social contacts in groups both large and small, enhanced by the setting of a dignified and beautiful ballroom.

The daylight hours Thursday were devoted to six Technical Division sessions. Sewage problems of special local interest and others of greater scope made up the program of the Sanitary Engineering Division. A symposium on "Organization and Operation of the Port of New York" was the feature of the meeting of the Waterways Division, which had both morning and afternoon sessions. The principal topics scheduled for discussion on the program of the Soil Mechanics and Foundations Division were "The Design of Building Foundations as Influenced by Developments in Soil Mechanics," and "Settlement Due to Excavation." A proposed manual on "Selected Bibliography on Soil Mechanics" was also presented at this session. The Highway Division considered the topics, "Channelization of Motor Traffic," and "Investigation of the Expansion of Concrete as Influenced by a Chemical Reaction Between the Type of Cement and Type of Aggregate." The subjects scheduled for discussion on the Structural Division's program were "Fatigue Failures in Service," "Review of European Data on Fatigue and Impact in Structures," and "Critical Review of Static and Fatigue Tests of Riveted Joints."

Thursday evening the members and their guests met at the Mecca Temple Casino. It would be more accurate to say that they monopolized its facilities, which could hardly have accommodated another person. To many, this "Beefsteak Supper," was a distinct innovation. The photographs of the event will give some idea of the setting, including the picturesque garb of waiters' white aprons and fantastic paper caps. But no photograph could give a fitting impression of the meal itself. Anyone with a carnivorous taste would relish this supper, and the liquid refreshment that went with it. Judging by the dexterity with which the large platters of food were polished off one after another, every one brought an appetite and ate with relish. Noise devices and colored balloons added to the gaiety. Following this, a floor show of dancing, music, and sleight of hand was provided. This unique modification of the usual Society smoker seemed to meet with general approval.

In the meantime, the ladies were not being neglected. In the afternoon they were conducted on a behind-the-scenes tour of Macy's department store, followed by a delightful tea in the store's restaurant. This vast establishment offered many interesting and instructive sights to the large group of ladies and the trip was acclaimed a great success. In the evening those who could do so went to the Radio City Music Hall, where they enjoyed a high-grade entertainment of music, stage show, and moving pictures.

Mention should also be made of the many luncheons and dinners held in connection with the Annual Meeting by college engineering groups. Get-together luncheons on Thursday were held by the Brown Engineering Association, the Chi Epsilon Honorary Civil Engineering Fraternity, and the M. I. T. Alumni. In the evening, dinners were scheduled by engineering alumni from the University of Illinois, Lehigh University, and others, who gathered informally at the Beefsteak Supper, and by the University of Pennsylvania, which met separately. Similar gatherings on Friday included the Columbia Engineers dinner, a dinner of the Cornell Society of Engineers, the Harvard-Yale-Princeton Annual Huddle, and the annual meeting and dinner of the Thayer Society of Engineers of Dartmouth College. On Saturday the Clarkson College Alumni scheduled a series of events, including a dinner

Concluding sessions were held on Friday morning by a number of the Divisions. The Structural Division scheduled a progress report and two final reports; and in addition problems of concrete design, current state highway department practice in the design of abutments, and concrete slabs were also discussed. The Power Division enjoyed a panel discussion on its policy and program for future work, and the City Planning Division also met. The principal feature of the latter program was a symposium on "Community Planning Measures to Be Undertaken During Neutrality as Part of a Preparedness Program."

These sessions ended in time to permit a large number of members to take in inspection and sightseeing trips in New York City during the afternoon. A tour of the rapidly progressing Queens-

of the Annual Meeting in New York, Draws Large Attendance

Midtown Tunnel proved most popular. The Society was the first outside group permitted to inspect the extensive project, starting from the Manhattan side and continuing all the way through. Other interested groups of members visited engineering laboratories—one for sanitary engineering at New York University and another for soil mechanics at Columbia University. Still others enjoyed motion pictures shown by the New York Board of Water Supply at Headquarters, covering tunnel and dam construction and hydraulic model tests.

One trip not on the advance schedule also proved most popular. This started at Headquarters by bus, proceeding direct to the North Beach Airport near the World's Fair, now known as LaGuardia Field. There a fine lunch was immediately served, following which the party was addressed by Mayor LaGuardia and invited to inspect various city engineering features. The remainder of the afternoon was spent in visiting the air and seaplane terminals, the repair shops, and the vast new hangars under construction.

Similarly, on Saturday, a number of interesting options in the way of inspection trips were open. One group traveled by subway to meet at the housing project being prosecuted by the Metropolitan Life Insurance Company, known as "Parkchester" in northern New York City. This is the most ambitious undertaking of its type to date—involving an expenditure of about $50,000,000. A considerably longer trip was scheduled to inspect parkway and bridge construction throughout greater New York. It started by automobile from Central Park and proceeded north into southern Westchester County, then east and south to the Whitestone Bridge; then a long circuit was made through Long Island parkways as far as Rockaway Beach and return in the late afternoon by the World's Fair and Triborough Bridge. Luncheon was enjoyed en route; Park Commissioner Moses was the principal speaker at the exercises in connection with this stop.

Still another trip permitted the inspection of sanitary projects in New Jersey. This was held in connection with the annual meeting of the New York State Sewage Works Association, in the sessions of which all day Friday many Society members joined, in return for similar privileges accorded its members at the Sanitary Engineering Division sessions of the Society on Thursday. The Saturday inspection trip left in good time from New York City and visited points in northern New Jersey, with lunch en route.

With these trips the Eighty-Seventh Annual Meeting came to a close. Much credit for its success should go to the various committees who arranged the multitudinous details and who were responsible for the smooth running of the various events. No detail seemed to have been overlooked, and so the entire meeting was voted on all sides to have been a complete success.

Myddelton Cup Replica to Society

Presentation by Ambassador Takes Place in Washington, D.C., January 9

BEFORE ABOUT 300 members and guests of the Society, the British Ambassador on January 9 made the formal presentation of the Myddelton Cup replica on behalf of the Institution of Civil Engineers. The ceremony took place at the Annual Dinner and Ladies' Night of the District of Columbia Section in Washington, D.C., with President Sawyer and other national officers in attendance.

The cup, "a token of friendship and esteem" for the Society, was originally to have been presented by the President of the Institution

LORD LOTHIAN, BRITISH AMBASSADOR, PRESENTS CUP TO PRESIDENT SAWYER AS MESSRS. W. E. REYNOLDS (LEFT) AND JOHN CARMODY (RIGHT) LOOK ON

as a highlight of the British American Engineering Congress, planned for last September. The alternate celebration was arranged when war put an end to the Congress plans.

In his address Lord Lothian, the ambassador, referred at some length to the origin and significance of the cup. "Some of you may have wondered as I did," he said, "why the Institution of Civil Engineers should have taken it as their model. . . .

"One reason for the choice lay no doubt in the intrinsic beauty of the cup itself. It is a fine example of the late sixteenth century English work, and the original was indeed thought worthy to be shown this summer at the British Pavilion at the World's Fair. But I can discern another reason which I should like to think played some part in the decision. It lies in the achievements and even more in the character of Hugh Myddelton himself.

"Of Myddelton's title to be considered a civil engineer I should be the last to speak in this company of experts. But you may, I hope, find some merit in the reasons quoted by the letters patent by which King James I conferred on him a baronetcy in 1622. They were as follows:

"'1. For bringing to the City of London, with excessive charge and great difficulty, a new cutt or river of fresh water, to the great benefit and inestimable preservation thereof. [Lord Lothian was quick to explain the seventeenth century significance of 'charge' as 'effort,' both here and in third paragraph of his quotation.]

"'2. For gaining a very great and spacious quantity of land in Brading Haven in the Isle of Wight, out of the bowells of the sea and with banks and dykes and most strange defensible and chargeable mountains, fortifying the same against the violence and fury of the waves.

"'3. For finding out, with a fortunate and prosperous skill, exceeding industry, and noe small charge in the County of Cardigan, a royal and rych myne, from whence he hath extracted many silver plates which have been coyned in the Tower of London for current money of England.'

"These achievements, it is true, are puny beside such modern achievements as the great New York, San Francisco, and Sydney bridges, the Boulder and the Grand Coulee dams, the Aswan Dam or the vast barrage across the Indus, and the latest triumphs of steel and concrete construction in your great modern buildings. But they do unquestionably show that Myddelton possessed the true character of an Elizabethan Englishman. Of the 'enquiring mind' which was above all the mark of that age, he had his full share. . . .

"In this distinguished company, among you who are the heirs of his qualities, and of his profession, I venture to think Hugh Myddelton would have found himself very much at home.

"Viewed in this way, I think that a replica of the Myddelton Cup is a most fitting vessel in which to convey to the American Society of Civil Engineers the warm feelings of esteem and admiration in which they are held by their brethren in Great Britain. In the same spirit and on behalf of the Institution of Civil Engineers I ask you, Sir, to accept this Cup."

President Sawyer responded on behalf of the Society, extending its appreciation and warm wishes to the Institution and expressing the hope that "English engineers soon may be free to devote their talents to peaceful pursuits." An address by Federal Works Administrator John Carmody concluded the program.

The cup was brought to New York by Secretary Seabury, and will remain permanently on display at Society Headquarters.

A Biographical Note on Hugh Myddelton

HUGH MYDDELTON was born in North Wales, in or about 1555. He was entered an apprentice of the Guild of the Goldsmiths Company, London, being admitted to the company in 1580. Later he

became a Merchant Venturer and embarked in ventures of trade by sea and land, and his varied activities, which included a prosperous clothmaking business, proved him to be a man of resource and enterprise.

In 1603, Myddelton was elected member of Parliament, and it was then that he first took an active interest in the subject of London's water supply. Local springs and wells from which water was conducted to public cisterns and fountains, were proving inadequate for the increasing needs of the inhabitants, and proposals for fetching water from distant sources had been mooted for some time. In 1605, the Corporation of the City of London obtained an Act for bringing a fresh stream of running water to the northern parts of London from springs at Chadwell and Amwell and other springs in the County of Hertford. Another Act was passed in the following year giving ampler powers, but the corporation were reluctant to proceed with an undertaking which was regarded as highly speculative in character, and readily agreed to an offer made by Myddelton to finance and carry out the work. It may be noted that he had acquired considerable practical knowledge in the arts of mining and excavation in connection with certain schemes he had promoted in Denbigh. Further, he was a friend of Sir Walter Raleigh and through him must have come in contact with Sir Francis Drake, who had been successful, some ten years earlier, in bringing water from Dartmouth to Plymouth, a distance of some eighteen miles, in an open cutting or leet, still in use and known as Drake's Leet. An indenture between the Corporation of London and Myddelton was executed in April 1609, and the project was begun.

Replica of Myddelton Cup Presented to the Society

The general plan adopted in cutting the "New River," as it was called, was to follow as far as practicable a contour line from the level of the Chadwell Spring, near Ware, with a slight gradient to the circular pond at Islington, known as the New River Head, upon the site of which stands today the headquarters of the Metropolitan Water Board. Although the distance between London and Ware was only twenty miles, the New River, when constructed, was about thirty-nine miles in length, with a gradient of approximately two feet per mile. In its course it was led along the sides of hills, from which sufficient soil was excavated to form the lower bank of the stream. Where valleys had to be crossed, the river was conducted by means of troughs lined with lead, the drainage waters passing under the river through culverts and the passage of roads beneath the waterway being provided for by arched openings formed in the embankment. The passage of drainage waters over the river was effected by means of timber troughs termed "flashes." At Bush Hill, Edmonton, the New River was conveyed along a strong timber trough (660 ft long, 5 ft wide, and 5 ft deep) resting on brick piers, whence arose the name of the "Boarded River"; a wooden aqueduct, 462 ft long and 17 ft high, fulfilled the same purpose over the valley where the river entered the parish of Islington.

The engineering problems which Myddelton had to face were considerable, having regard to the state of knowledge and the lack of facilities at this period of history, but they were nothing to the difficulties which he encountered in meeting objections of owners and occupiers of lands through which the New River passed. Agitation against the proposed works was vigorously pressed in Parliament, but Myddelton was strongly supported by James I, with whom he had done business as a goldsmith and banker; and in 1612 the King promised to pay half the costs of the enterprise on receiving a half share of the profits. The work was completed in 1613, and to commemorate the great benefits which it conferred upon the inhabitants of London, the Goldsmiths Company (London) presented Myddelton with the silver-gilt cup whose replica has just been given the Society. And a few years later, for his water supply work and for other public services as well, King James conferred a baronetcy upon him.

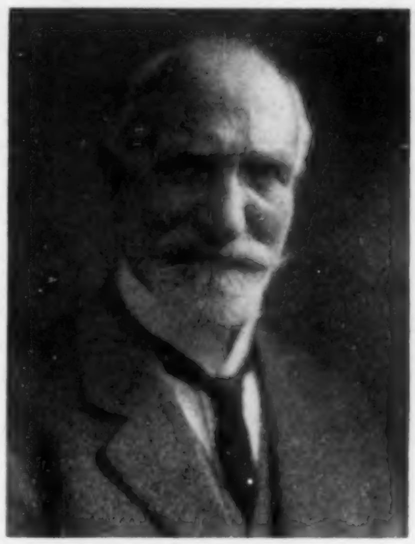
Myddelton has been described as a great *entrepreneur*, and without fuller knowledge of the part he played in solving the engineering problems in connection with the schemes with which he was concerned, this appears to be more correct than to refer to him as a great engineer, as the term is understood today. There is reason to believe, however, that he possessed that innate sense of the fitness of things engineering, which characterized the civil engineers of the following century. To this extent, it may be claimed for him that he was one of the earliest men of English birth to undertake important engineering works in his native land. Up to his time, and even later, such enterprises were carried out by foreigners: thus the Great Level of the Fens was drained by the Dutchman, Vermuyden, the Thames at Westminster was bridged by a Frenchman, Labelye, the first cannon was cast at Baxted by a Frenchman, Baude, and when Dover Harbour was threatened by ruin in Henry VIII's reign, a Fleming, Poins, was engaged to carry out remedial works.—*From a Brochure Prepared by the Institution of Civil Engineers.*

Charles David Marx, 1857–1939

Charles David Marx, Past-President and Honorary Member of the Society, died at Palo Alto, Calif., on December 31, 1939. Dr. Marx, who was 82, was emeritus professor of civil engineering at Stanford University.

Born in Toledo, Ohio, he received part of his education in Amsterdam, Holland, where his father was United States Consul. Later he studied at Cornell University, from which he was graduated in 1878, and at the Karlsruhe Polytechnikum. In later years he was the recipient of honorary degrees from the University of California and the Karlsruhe Technische Hochschule.

From 1884 to 1890 he was assistant professor of civil engineering at Stanford University. He then served for a year as professor of civil engineering at the University of Wisconsin, but in 1891 received a call from David Starr Jordan, president of the newly founded Stanford University, to become a member of the university's pioneer faculty. Dr. Marx remained at Stanford until his retirement in 1923.



Charles David Marx

In addition to his teaching, he was engaged as consultant on many important projects, including Hoover Dam, the Golden Gate Bridge, the Central Valley Project, San Gabriel Dam No. 1, and numerous others. Dr. Marx was the first chairman of the California State Water Commission, organized in 1911, and played an important part in framing the water laws of the state of California. For many years, also, he was active in the civic affairs of the city of Palo Alto.

Dr. Marx, or "Daddy Marx" as he was affectionately known far and wide, will long be remembered at Stanford for his unfailing personal interest in his students, who retained their admiration and love for him long after graduation. He was active in many engineering organizations, including the San Francisco Section of the Society. He became a member of the Society in 1896; he served as Director from 1904 to 1906; as Vice-President in 1912 and 1913; and as President in 1915. He was elected Honorary Member in 1927.

Factual Survey of Members

Professional, Social, and Economic Status in 1938 Reported

AS AUTHORIZED by the Board of Direction and as noted in CIVIL ENGINEERING for July 1939, page 439, the Society's Committee on Professional Objectives canvassed the membership by mail in order to survey the 1938 compensation and status of the Society's membership. The returns, coded and tabulated by the Committee on Salaries during December 1939, were reported to the Board of Direction at its January meeting and ordered published.

GENERAL RESULTS

The response to the questionnaire was notable. Of the 16,040 cards mailed, 7,988 were returned in time to be included in the analysis. The returns were widely distributed geographically, by membership grade and by age, and they appear to be comprehensive and as truly representative a sample of the membership as could be expected. The usable returns were from 2,629 Members, 2,847 Associate Members, 2,483 Juniors, and 29 of other grades. By ages, 1,823 returns were from members less than 30 years of age, 5,980 from members between 30 and 70, and 185 from members over age 70.

About 85 per cent of the replying members are shown to be college graduates; 90 per cent of such corporate members are married, while 45 per cent of the Juniors are still bachelors. One-third of the members reported holding civil service positions. Only 3.5 per cent reported no earnings whatever during 1938; another 2.8 per cent reported employment for less than 6 months.

INCOMES REPORTED

From a previous study of the distribution of the membership of the Society by ages (CIVIL ENGINEERING, May 1939), and the age of those returning cards in this survey, the ratio of returns to the total membership at each age was determined and plotted in Fig. 1. A larger proportion of young members at age 25 made returns than did the older ones; that is, while about 68 per cent of all members at age 25 made returns, only 50 per cent of those at age 45 sent in cards, and 38 per cent of those at age 60. The

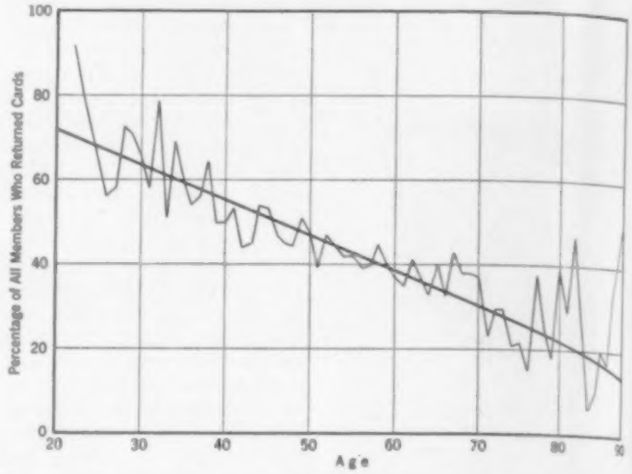


FIG. 1. RATIO OF RETURNS TO TOTAL MEMBERSHIP AT EACH AGE

TABLE I. AVERAGE ANNUAL EARNINGS OF MEMBERS (ALL GRADES) EMPLOYED FULL TIME BY STATES

New York	$5,270	Michigan	$3,898
*Puerto Rico	5,254	West Virginia	3,873
*Philippine Islands	5,051	Alabama	3,867
Foreign	5,028	Texas	3,818
Massachusetts	5,019	Virgin Islands	3,800
*Hawaii	4,946	*South Carolina	3,673
*Maine	4,787	Arizona	3,657
Illinois	4,704	Kansas	3,578
Maryland	4,664	Georgia	3,441
Minnesota	4,645	Oregon	3,437
*Louisiana	4,510	*Canal Zone	3,416
District of Columbia	4,294	Washington	3,346
Nebraska	4,241	Colorado	3,240
Missouri	4,196	Kentucky	3,226
*Delaware	4,162	*New Hampshire	3,224
Pennsylvania	4,149	*New Mexico	3,205
Tennessee	4,142	Utah	3,188
North Carolina	4,142	Indiana	3,169
Ohio	4,140	*Wyoming	3,125
Connecticut	4,131	Arkansas	3,105
New Jersey	4,057	*Montana	3,078
California	3,997	Oklahoma	3,008
Virginia	3,979	Mississippi	2,853
Florida	3,954	*Vermont	2,837
Wisconsin	3,948	*Nevada	2,825
*Rhode Island	3,928	*Idaho	2,794
*Alaska	3,926	*North Dakota	2,662
Iowa	3,908	*South Dakota	2,220

* Less than 50 in group.

TABLE II. AVERAGE ANNUAL INCOMES OF ALL REPORTING, BY AGE AND MEMBERSHIP GRADE

Note: These are for exact age given. For example, this table does not include any who are 41, or 42, or 43, or 44.

	Juniors		Associates		Members		All	
Age	No.	Av. Income	No.	Av. Income	No.	Av. Income	No.	Av. Income
25	242	1,654	...	.....	...	.....	242	1,654
30	238	2,257	14	3,447	...	.....	252	2,318
35	...	.....	182	3,114	10	3,079	193	3,110
40	...	.....	114	3,861	30	5,735	144	4,251
45	...	.....	73	4,186	40	6,312	113	4,939
50	...	.....	81	4,402	103	6,548	184	5,603
55	...	.....	60	5,209	116	6,602	176	6,133
60	...	.....	27	4,327	73	6,905	100	6,210
65	...	.....	...	.....	58	6,934	62	6,752
70	...	.....	...	.....	27	6,752	28	6,779

TABLE III. AVERAGE INCOMES OF ALL REPORTING, BY YEARS AFTER GRADUATION AND MEMBERSHIP GRADE

Notes: These are for exact ages given. For example, the table does not include any data for those 11 years, 12 years, 13 years, or 14 years out of college.

This table is not comparable with Table II because quite a number of Member grade have recently graduated.

Years Since Graduation	Junior	Associate Member	Member
5	$2,158	$2,612	$3,432
10	2,713	3,049	3,745
15	....	3,735	4,396
20	....	4,000	5,655
25	....	4,324	5,731
30	....	5,616	7,142
35	....	5,800	7,210
40	....	4,177	6,000
45	....	4,450	7,532
50	....	3,200	3,647

TABLE IV. AVERAGE SALARY, BY TYPE OF EMPLOYER, FOR ALL MEMBERS, ALL GRADES, REPORTING FULL-TIME EMPLOYMENT

Employer	Number	Average Salary
Foreign government	15	$9,148
Not stated	89	6,426
Technical organization	18	5,736
Self	937	5,408
Contractor	585	4,870
Editorial	9	4,745
Public utility	381	4,656
Railroad	171	4,508
Miscellaneous	67	4,503
Quasi-governmental	56	4,403
Non-engineering	53	4,024
General average	7,533*	3,970
City	416	3,805
Street railway	7	3,721
Colleges	320	3,721
Governmental (subdivisions not stated)	721	3,620
Average governmental (all types)	4.180	3,403
County	51	3,360
None (as stated)	10	3,347
State	1,432	3,275
Federal	1,382	3,245
Governmental (alphabetical)	116	2,891

*Total of all reporting as to type of employer.

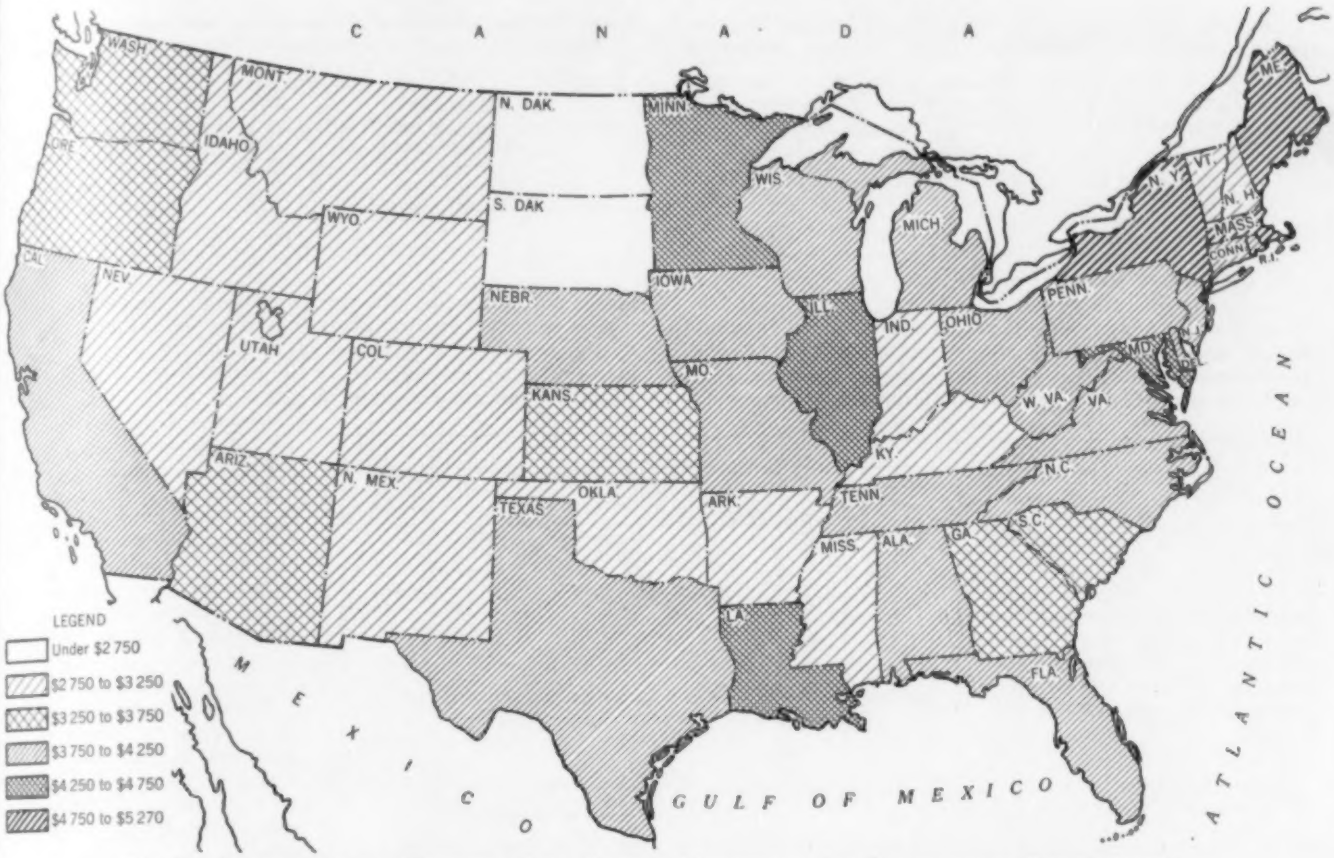


Fig. 2. Average Annual Earnings, Full Time, of Members of All Grades in the United States

larger number of low incomes of young members and the smaller number of high incomes of older men is such that the indicated average incomes derived from the data are conservative.

In Table I is shown the average earning of all replying members who were fully employed, from the youngest Junior to the oldest corporate member, by states, ranging from $5,270 in New York State to $2,220 in South Dakota. In Fig. 2 these results are shown geographically. Several conclusions are clear. Each state bordering on a sea coast or on the Great Lakes is in a favorable income position. Indiana and Kentucky appear to be surrounded by states of higher professional income. The Rocky Mountain states are in a medium income group.

The average income of all members in all grades reporting, both employed and unemployed, was $3,752; of all Juniors, $1,856; of all Associate Members, $3,721; of all Members, $5,503. These grades of membership have been separated into age groups in Table II and the data are shown graphically in Fig. 3. It appears that those who have qualified for membership in the Society continue to enjoy increasing incomes as experience increases even up to the biblical life span of three score and ten. The income of Members is

Table V. Average Salary by Field of Work, for All Members, All Grades, Reporting Full-Time Employment

Field	Number	Average Salary
Administration	59	$6,292
Not stated	340	5,785
Heavy construction	109	5,364
Harbor work	60	5,175
General engineering	501	4,809
Structures (general)	601	4,284
Transportation	201	4,248
Bridges and buildings	86	4,146
Structures (miscellaneous)	150	4,125
Power	271	4,114
Water supply	328	4,081
General average (of incomes)	7,547*	3,969*
Municipal engineering	96	3,979
Buildings	558	3,900
Sanitation	565	3,892
Hydrology	332	3,794
Irrigation	89	3,751
Bridges	609	3,580
Dams	117	3,571
River improvement	92	3,554
Teaching	96	3,378
Streets and highways	829	3,264
Waterways	54	3,245
Reclamation	287	3,236
Flood control	363	3,020
Conservation	64	2,829
Surveying	168	2,821
All others	522	4,391
Not stated	293	....
Various specialties	148	....

*Total of all reporting as to field of work.

Table VI. Average Salary by Job Function, for All Members, All Grades, Reporting Full-Time Employment

Function	Number	Average Salary
Consulting	72	$7,644
Not stated	270	6,517
Management	169	6,201
Administration	633	6,194
Supervision and other	129	5,277
Supervision—departmental	51	5,038
General engineering	107	5,030
Design and supervision	116	5,000
Design and construction	874	4,492
Supervision—field	260	4,103
Teaching and other	86	4,050
Design and research	114	4,044
Operation and maintenance	54	4,000
Valuation and other	51	3,867
Sales engineering	119	3,844
Teaching	334	3,591
Construction	883	3,566
Investigation and other	97	3,532
Design and other	280	3,494
Research and other	110	3,441
Office engineer	83	3,425
Research	369	3,362
Design	1,033	3,332
Construction and other	212	2,811
Misc. specialties	69	2,800
Estimating and other	50	2,602
Inspection and other	126	2,439
Surveying and other	177	2,332
Computing and estimating	81	2,329
Surveying	298	2,023
Drafting and other	142	1,568
All other	96	1,568

TABLE VII. DISTRIBUTION OF EARNINGS BY INCOME BRACKETS AND CORRESPONDING MEMBERS (ALL GRADES) REPORTING

Income Bracket	Number of Members Reporting	Income Per Cent
$ 0 to $ 2,499	2,457	32.6
2,500 to 4,999	3,384	44.9
5,000 to 7,499	1,078	14.3
7,500 to 9,999	299	4.0
10 000 to 24,999	283	3.7
25,000 to 75,000	40	0.5
Total	7,541	100.0

TABLE VIII. ESTIMATED PERCENTAGE DISTRIBUTION OF ALL FEDERAL INCOME TAX RETURNS BY INCOME BRACKETS FOR YEAR GIVEN

Income Bracket	1930	1933
$ 0 to $2,499	40.0	63.9
2,500 to 4,999	38.1	27.2
5,000 to 7,499	8.8	3.5
7,500 to 9,999	6.1	2.7
10,000 and above	7.0	2.7
	100.0	100.0

higher than that of Associate Members for each age. For example, the average income of Members 50 years of age is $2,150 more than that of Associate Members of the same age. Similar conclusions may be drawn from the data in Table III graphically presented in Fig. 4, but it should be noted in studying Table III that quite a few of the members in the corporate grades have but recently graduated.

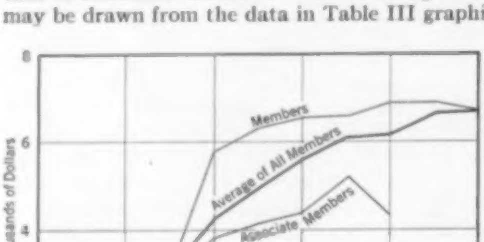


FIG. 3. AVERAGE ANNUAL INCOME OF ALL THOSE REPORTING BY AGE AND MEMBERSHIP GRADE

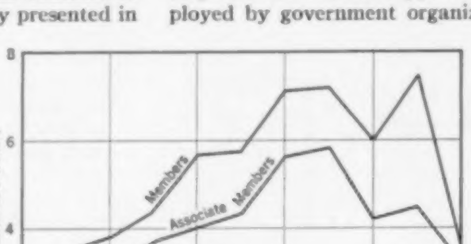


FIG. 4. INCOME BY YEARS SINCE GRADUATION

In Tables IV, V, and VI are shown the average incomes of all members in all grades who reported full-time income in 1938 by type of employer, by field of work, and by job function. It is to be observed that 55 per cent of those reporting (and presumably this same factor applies to the entire membership) are employed by government organizations of all types—federal, state, county, or city—and that the average income of the group is just over $3,400 as compared with the general average of $3,970 for all full-time members. Administration and management positions are well compensated as are also those engaged in heavy construction and harbor work. It is notable that engineering teachers receive less than the average member.

Tables VII and VIII attempt to show how the income of the profession as represented by the membership in 1938 compares with the income of the population of the United States as a whole.

Unemployment, wholly or partially, among reporting members was surprisingly low. This fact may have important bearing on the necessity or type of an amplified placement service. The Committee on Professional Objectives has undertaken a careful study of the details and implications of this survey.

St. Louis Sponsors Student Chapter Gathering

UNDER the sponsorship of the St. Louis Local Section and with the Student Chapter at Washington University acting as host, representatives from eight Student Chapters gathered on Saturday afternoon, December 9, 1939, to lay plans for a program for the Student Conference to be held at the time of the Spring Meeting in Kansas City, Mo., in April 1940. Student attendance from the Chapters was as follows: University of Arkansas, 2; University of Illinois, 1; Kansas State College, 1; University of Kansas, 1; University of Missouri, 13; Missouri School of Mines, 3; University of Nebraska, 4; and Washington University, 14. There were present also six faculty advisers, a Junior contact member, Director Robert B. Brooks, and John H. Porter, member of the Society's Committee on Student Chapters. T. H. McCrackin, of the University of Illinois Chapter, was chosen by lot as presiding officer.

Following brief remarks by Mr. Porter and Director Brooks, Chairman McCrackin opened the conference by calling for a canvass of opinion on the type of program desired. It is hoped to have all Chapters in the vicinity represented at the conference next April. The invitation of the University of Kansas Chapter to act as host for the conference was unanimously accepted.

There was lively discussion from the floor on the advantages and disadvantages of various types of programs, involving various combinations of addresses by older engineers, discussion of controversial topics, technical student papers, professional questions, inspection trips, and social gatherings. Throughout the discussion it was recognized that the plans and conduct of the student conference should be entirely in the hands of students.

It was also decided to form a Midwest Regional Student Chapter Conference, the organizational meeting to be in Kansas City next April.

The following program was finally adopted, authority being given to the Kansas University Chapter to make necessary changes:

MORNING—Opening addresses
A paper and discussion on personnel
Paper and slides on construction of Pensacola Dam

LUNCHEON—

AFTERNOON—Address by a distinguished member of the Society followed by discussion
Organization meeting, Student Chapter Regional Conference

The conference reported above was part of a two-day program sponsored by the St. Louis Section in connection with its annual gathering and dinner. Inspection trips for the students were conducted on Friday afternoon. William C. E. Becker, M. Am. Soc. C.E., designer of the Jewel Box, the large flower display building in Forest Park, explained the intricate studies made for its design and location. Also an engineer for the Forest Park Zoo explained the engineering details of design of the zoo buildings.

On Friday evening some of the students attended the R.O.T.C. annual ball. On Saturday morning several engineers of the Anheuser-Busch Brewery conducted the group over the plant. Later a visit was made to bridges over the Mississippi River, in the course of which E. B. Fay, M. Am. Soc. C.E., consulting bridge engineer, described their construction and engineering features.

Following the student conference all members of the visiting groups attended the annual dinner of the St. Louis Section as guests of the Section.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies in 40 States

To Study Superhighway

Formation of a committee to report upon possible routes, costs, financing, and other problems relating to the construction of a new high-speed superhighway between Boston, Mass., and Washington, D.C., resulted from a recent meeting in New York City attended by highway officials of the eight states directly concerned and by Public Roads Administrator Thomas H. MacDonald. The committee is expected to report in several months.

The new road, which would cost in the neighborhood of $200,000,000, is advocated as a present necessity to relieve traffic congestion in an area occupied by one-quarter of the population of the United States, and also as a potential factor in the national defense. It presents many problems, of which the matter of financing is most important. An official study by the Public Roads Administration found that such an undertaking could not be self-supporting on a toll basis, but it is hoped that some form of federal-state cooperation can be worked out. R. Donald Sterner, State Highway Commissioner of New Jersey, is chairman of the committee.

Power Costs Analyzed

Residential, commercial, and industrial bills for electric power in the 48 states as of January 1, 1939, are analyzed in a comprehensive 73-page report issued by the Federal Power Commission. Data for this study are taken from the commission's rate series, already issued for each state. The report is designated as F.P.C. R-17, and can be obtained from the commission for 10 cents per copy. It is in five parts, the first comparing bills in the various classes by states and geographic regions; the second comparing bills according to sizes of communities; the third those submitted by private and by public utilities; the fourth, electricity costs in 1935, 1937, and 1939. The final section discusses the statistical methods used in averaging the data contained in the state series.

In a separate release the commission reports that the average daily production of electric power for public use during November 1939, established a new all-time high for the third consecutive month. For the 30-day period, production totaled 11,456,100,000 kwhr, a daily average of 381,870,000 kwhr. This is an increase of 1.4% over October 1939, and 13.4% over November 1938.

Bill Would Bar Politics by State Employees

Amendments of the law passed last year by Congress forbidding political activities by employees of the federal government to extend the same prohibitions over state employees administering federal funds has been proposed by Senator Hatch of New Mexico, sponsor of the original measure. The new bill, if passed, would apply particularly to state highway departments, which customarily receive federal-aid contributions toward road-building expenses, but would also affect any other state departments supported in part by federal contributions.

Dismissal of the offending employee, the penalty provided for violating the present act, cannot be applied directly to state employees because the federal government has no authority over them. Accordingly, in the amendment it is provided that the federal government shall withhold loans or grants from any state department, the head of which refuses to discharge an employee engaging in political activity.

Canadian–United States Negotiations Resumed on St. Lawrence Waterway

Final agreement on the details of a treaty between the United States and Canada for the construction of the long-advocated St. Lawrence waterway, which would admit ocean-going steamers to the Great Lakes and develop a large quantity of low-cost power, is being sought by negotiators representing the two countries. The United States has sent to Ottawa a three-man delegation for this purpose composed of Assistant Secretary of State Adolph A. Berle, Chairman Leland Olds of the Federal Power Commission, and John Hickerson, assistant chief of the State Department's division of European affairs.

Before becoming effective the treaty must be ratified by both governments, and powerful opposition has been expressed to it in both countries. The Canadian attitude, it has been reported, is much more favorable now than formerly because of the increased need of Canadian industry for power to fulfill war requirements. In the United States opinion is divided along sectional lines, the waterway being favored by shippers of bulk products, such as wheat, in the Mid-West, and opposed by Eastern states which fear the resulting diversion of traffic from their seaports.

Washington, D.C.
January 5, 1940

Forecast for February "Proceedings"

Measuring the Potential Traffic of a Proposed Vehicular Crossing

By N. Cherniack, Assoc. M. Am. Soc. C.E.

Experience of a traffic engineer and statistical analyst applied to the trans-river crossings administered by the Port of New York Authority

Design of Hinges and Articulations in Reinforced Concrete

By George C. Ernst, Assoc. M. Am. Soc. C.E.

An explanation of the action of Mesnager and Considère articulations, and the presentation of a design method.

Axioms in Roadway Soil Mechanics

By Henry C. Porter

A discussion of broad principles presented for discussion as axioms.

Sealing the Lagoon Lining at Treasure Island with Salt

By Charles H. Lee, M. Am. Soc. C.E.

Novel method of sealing a 10-in. clay lining of a lagoon at the Golden Gate International Exposition by a priming of salt water.

Progress Report of the Committee on Flood Control

Comprising "a general appraisal of methods, with particular reference to their physical and economic limitations."

Library Serves Engineers in Distant Lands

Latest addition to the Engineering Societies Library's growing collection of bi-lingual aids is an English-Turkish technical dictionary, the work and donation of L. A. Scipio, dean of engineering at Istanbul American College. In making the presentation he wrote:

"Living in this part of the world, it is not always easy to get information which I desire and you and your staff have been so helpful to me for many years that I want to do some little thing in return. It has taken me two and a half years to prepare this little dictionary, and since our engineering body in New York is of such cosmopolitan character, it is just possible that someone may find use for it."

The donor of this volume is but one of hundreds who each year make use of the mail-order services of the Engineering Societies Library. Its assistance to engineers in all parts of the world ranges from suggesting an authoritative book or a few articles on a given subject to compiling comprehensive bibliographies for use in engineering projects, making exhaustive literature searches to aid in patent litigation, or preparing English translations of technical papers in foreign languages. It is also equipped to supply photostatic copies of material in its collection, and maintains a rental collection for members of the Founder Societies. All services are rendered at cost.

Twenty-Fifth Anniversary of Maryland Section

ON DECEMBER 12 the Maryland Section held its annual meeting and, at the same time, celebrated its twenty-fifth anniversary. Dinner for 108 members and guests preceded the formal session, which was opened by E. J. Dougherty, president of the Section. In presenting his report for the year, Mr. Dougherty stated that the Section's major achievements have consisted of getting an engineers' registration bill passed and of building up the regular meeting attendance. He was followed by James A. Anderson, Director of the Society, who spoke briefly.

The guest of honor and principal speaker of the evening was Donald H. Sawyer, President of the Society. In discussing the status of the civil engineer, Colonel Sawyer said that no group has contributed so much to the advancement of civilization in the United States as engineers. "In times like these," he added, "the best type of man is demanded for public service and we fill the bill."

During the business session various reports were heard, including that of Frank Hall, president of the Junior Association, who outlined the activities of the Association during the past year. The election of officers for 1940, also held at this time, resulted in the selection of George E. Finck for president, and E. M. Killough, for vice-president. Norman D. Kenney will continue as secretary-treasurer for another year. A few remarks by President-elect Finck concluded the program.

News of Local Sections

Scheduled Meetings

COLORADO SECTION—Dinner meeting at the University Club on February 12, at 6:30 p.m.

DAYTON SECTION—Luncheon meeting at the Dayton Engineers' Club on February 19, at 12:15 p.m.

GEORGIA SECTION—Luncheon meeting at the Atlanta Hotel on February 12, at 12:30 p.m.

IOWA SECTION—Talk and discussion at the Iowa State College on February 28, at 8 p.m.

KANSAS STATE SECTION—Annual dinner meeting at Wichita on February 8 and 9, to be held jointly with Kansas Engineering Society.

LOS ANGELES SECTION—Dinner meeting at the University Club on Feburay 14, at 6:30 p.m.

LOUISIANA SECTION—Technical meeting and smoker at the residence of Ole K. Olsen on February 9, at 8 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building, New York City, on February 21, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Seven Seas Restaurant on February 1, at 7 p.m.

MOHAWK-HUDSON SECTION—Dinner meeting at Union College on February 8, at 6:30 p.m.; meeting at 8 p.m. (Joint Meeting with A.I.E.E., A.S.M.E., N.Y. Prof. Eng., and Am. Weld Soc., of Schenectady, N.Y.).

NASHVILLE SECTION—Dinner meeting in the Vanderbilt University dining room on February 6, at 6:30.

OKLAHOMA SECTION—Joint meeting with the Student Chapters of Oklahoma A. & M. and University of Oklahoma (arranged by Oklahoma A. & M.) at Stillwater, Okla., on February 12.

OREGON SECTION—Technical meeting at the Public Service Building Auditorium on February 6, at 8 p.m.

PHILADELPHIA SECTION—Social meeting at the Engineers' Club on February 17, at 6:15 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks' Club every Tuesday at 12:10 p.m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on February 26, at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers' Club on February 20, at 5:30 p.m.

SEATTLE SECTION—Dinner meeting at the Engineers' Club on February 26, at 6 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Chattanooga Sub-Section at the Dining Hall, Y.W.C.A., on February 20, at 6:30 p.m.; dinner meeting of the Knoxville Sub-Section at the S. & W. Cafeteria on February 6, at 5:45 p.m.

Recent Activities

ARIZONA SECTION—*Phoenix, November 25:* This annual fall meeting took the form of an all-day session, with a banquet and dance in the evening. Following an address of welcome by Prof. John C. Park, of the University of Arizona, the annual election of officers took place with the following results: Vic Housholder, president; Julian Powers, first vice-president; and John Gardiner, second vice-president. W. T. Wishart will continue as secretary-treasurer for another year. The speakers scheduled for the morning session were Mr. Wishart, who gave a report on the Annual Convention of the Society; Director Charles T. Leeds and Raymond A. Hill, who discussed various aspects of the Society's policies; and A. M. Rawn, who presented a progress report of the Committee on Professional Objectives. The speakers on the technical program, scheduled for the afternoon, were Wayne O'Harra, chemist for the Arizona State Highway Department; Don Scott, of the Scott Engineering Company; F. C. Roberts, Jr., state sanitary engineer; E. S. Borgquist, professor of civil engineering at the University of Arizona; Dario Travaini, superintendent of sewers and sewage treatment for the city of Phoenix; and John Carollo, consulting engineer of Phoenix. At the luncheon a sound motion picture on the making of steel was shown through the courtesy of C. W. Heflin, of the Columbia Steel Company, and a talk on "The Professional Man in Civic Life" was given by Frank L. Snell, president of the Phoenix Chamber of Commerce.

BUFFALO SECTION—*November 14:* A lecture on "Mineral Resources and International Politics" followed luncheon. This was given by Reginald Pegrum, head of the geology department at the University of Buffalo.

CENTRAL OHIO SECTION—*December 8:* Annual joint dinner meeting with the Ohio State University Student Chapter. Claude White, president of the Chapter, discussed the formation of the North Central Student Chapter Conference. The following new officers were then inducted into office: R. B. Jennings, president; C. V. Youngquist, first vice-president; C. W. Allen, second vice-president; and C. H. Shepard, secretary-treasurer. Talks by the president-elect and Prof. H. R. Cotterman concluded the session.

CINCINNATI SECTION—*December 12:* Joint dinner meeting with the Student Chapter at the University of Cincinnati. A report on the North Central Student Chapter Conference was given by Harry Graham, while Hunter W. Hanly reviewed the Chattanooga Meeting held last spring. Following a talk by J. E. Root, Director of the Society, Frank L. Raschig, division engineer for the Ohio State Highway Department, was introduced. Mr. Raschig gave a talk on the organization, plans, and procedure of the department, supplementing his talk by sound motion pictures of the highway department's activities.

COLORADO SECTION—*Denver, December 11:* There was an unusually large attendance on this occasion—the annual "ladies' night." Following a dinner, certificates of life membership were presented to Richard W. Tull in person, and to Edward C. Jansen in absentia. Colored motion pictures depicting animal life and scenery in the Rocky Mountain region were then shown, and T. R. Agg, Director of the Society, discussed Society affairs and the forthcoming Annual Convention, which will be held in Denver. During the annual business meeting the following officers were elected for the coming year: Roy A. Klein, president; Ralph L. Parshall, vice-president; and Ralph N. Tracy, secretary-treasurer. Charles C. McNamara will serve as Junior representative to the president, while George J. Hoge will be Junior assistant to the secretary.

CONNECTICUT SECTION—*New Haven, December 14:* Over 55 members—the largest attendance in several years—were present at this meeting. Certificates of life membership were presented

to J. A. Norcross and A. H. Greenwood, both veteran members of the Section. Then George W. Burpee, consulting engineer of New York City, gave a talk on traffic surveys. The Section reports that it is obtaining excellent publicity, both in the Connecticut papers and in local radio broadcasts, for its meetings.

Dayton Section—*December 18:* At this luncheon meeting a certificate of life membership was presented to C. H. Paul, consulting engineer of Dayton. Mr. Paul then discussed unusual problems encountered in the planning and construction of Grand Coulee Dam. Special commendation was tendered William B. Nagel for his work in handling the Section publicity, and new officers were elected for 1940. These are J. J. Chamberlain, Jr., president; J. F. Hale, first vice-president; and M. W. Tatlock, second vice-president. C. H. Stephens will carry over as secretary-treasurer.

Florida Section—*Tallahassee, December 11:* The speaker was E. M. Menendez, of the South Eastern Telephone Company, who discussed the advisability of designing office and residential buildings with the proper provisions for telephone service in mind. *Gainesville, December 14:* A report on Junior activities was read by J. A. Riviere, chairman of the Committee on Juniors, and enthusiastically discussed by the membership. The Section then went on record as favoring a reduction in Society dues outside the New York area in order to encourage membership growth. *Jacksonville, December 21:* This was a business meeting followed by a banquet. The Section announces that John F. Reynolds will serve as president in 1940 and that Charles F. Lovan will be secretary-treasurer.

Georgia Section—*December 11:* During the annual business session A. J. Cooper was elected president, and Hal Hale and George A. Belden were elected vice-presidents. The retiring president, W. S. McDonald, gave a brief résumé of the Section's accomplishments in 1939, and Mr. Cooper responded that the Section's program for 1940 would not be essentially different. Mr. Hale also spoke briefly. Certificates of life membership were presented to Curtis A. Mees and to Kieffer Lindsey by J. W. Barnett, himself a Life Member.

Hawaii Section—*Honolulu, December 5:* The speaker of the evening was Carl B. Andrews, professor of civil engineering at the University of Hawaii and president of the Hawaii Section. Professor Andrews' talk was entitled "A Relationship Between the Chemical Composition and Physical Characteristics of Clay Soils."

Illinois Section—*Chicago, December 15:* The annual election of officers held at this time resulted as follows: J. deN. Macomb, president; G. B. Massey, vice-president; and C. P. Hazelet, secretary. The two latter were elected for two-year terms. W. W. De Berard, Director of the Society, discussed Society affairs and presented certificates of life membership. The recipients of this honor were C. B. Burdick, E. Haupt, L. J. Hotchkiss, B. G. Leake, L. J. Mensch, W. H. Penfield, L. K. Sherman, C. Older, O. Shanks, and R. A. Widdicombe.

Ithaca Section—*Elmira, December 12:* Joint meeting with the Steuben Area Chapter of the New York State Society of Professional Engineers. A paper on "Wind Pressures in Building Design" was given by George Howe, designing engineer for the American Bridge Company.

Kansas City (Mo.) Section—*December 7:* An open forum on "Current Events in Engineering" was the feature of this occasion. Each member discussed the work that he had on hand during the past year and spoke of future prospects. The annual election of officers resulted in the selection of R. N. Bergendoff, president; F. M. Cortelyou, first vice-president; W. M. Spann, second vice-president; and W. G. Fowler, secretary-treasurer. E. E. Howard was given a certificate of life membership.

Kansas State Section—*Topeka, December 15:* Following dinner Joseph Nickell and J. B. Buerkens spoke. Captain Nickell, who is an officer in the National Guard, discussed "Some Phases of Army Preparedness." A sound motion picture entitled "Navy Training and Aeroplane Performance" was then shown.

Kentucky Section—*Frankfort, December 15:* During this session the following officers were elected for 1940: D. H. Bray, president; W. W. Sanders, vice-president; and R. E. Shaver, secretary-treasurer. The technical program consisted of talks by F. M. Veatch, district engineer for the U.S. Geological Survey, and W. S. Downs, professor of railway and highway engineering at West Virginia University. Mr. Veatch gave an illustrated lecture on "Stream Gaging in Kentucky," while Professor Downs' subject was "Regulation of the Size and Weight of Motor Vehicles in Kentucky."

Los Angeles Section—*December:* The new officers for the Section (listed in the January issue) were installed, and certificates of life membership were presented to nine members. The speaker of the evening was James I. Ballard, editor of *Western Construction News,* who discussed engineering accomplishments in the Western states during the past year. *Junior Forum:* The Forum officers for 1940 are Sterling S. Green, president; Brooks T. Morris, vice-president; and George E. Brandow, secretary.

Metropolitan Section—*New York City, December 20:* Joint meeting with the New York section of the American Welding Society. The speakers were Jonathan Jones, chief engineer of fabricated steel construction for the Bethlehem Steel Company, whose subject was "Structural Welding in the Tacoma-Narrows Bridge"; and C. E. Loos, manager of the Structural and Plate Bureau of the Pittsburgh Carnegie-Illinois Steel Corporation, who read a paper on "Shear Tests of Plug and Slot Welds." F. H. Dill, who is on the staff of the American Bridge Company, was co-author of the latter paper. A feature of the meeting was the award of honorary membership in the American Welding Society to Frederick Thomas Llewellyn.

Nashville Section—*December 5:* W. C. Phillips, Tennessee state highway commissioner, gave a talk on the problems and accomplishments of the Tennessee State Highway Department. The following officers were elected to serve during 1940: L. R. Currey, Jr., president; W. T. St. Clair, vice-president; and W. L. Picton, secretary-treasurer.

New Mexico Section—*Albuquerque, December 6:* This annual meeting was devoted to business discussion. New officers were elected as follows: W. H. W. Yeo, president; Burton Dwyre, first vice-president; Alan Laflin, second vice-president; and Maurice Lipp, secretary-treasurer.

Northeastern Section—*Boston, December 6:* The guest speakers on this occasion were George T. Seabury, Secretary of the Society, and Walter E. Jessup, Field Secretary. Both discussed the activities of the Committee on Professional Objectives. There was some general discussion of this subject followed by the report of Prof. A. Haertlein, chairman of the Section's Committee on Professional Objectives.

Northwestern Section—*St. Paul, December 4:* A. E. Palen, district engineer for the Public Roads Administration, read a paper on "A Master Regional Highway Plan." This paper was discussed by O. L. Kipp, construction engineer for the Minnesota State Highway Department, and W. J. Titus, senior engineer for the Public Roads Administration. Certificates of life membership were then presented to H. S. Loeffler and Luther S. Oakes. The new officers for the Section are A. J. Duvall, president; W. J. Titus, first vice-president; Louis Yager, second vice-president; and Frank S. Altman, secretary-treasurer.

Oklahoma Section—*Oklahoma City, December 18:* Officers for 1940 were elected as follows: D. L. Wilson, president; C. H. Guernsey and D. A. Leach, vice-presidents; and C. E. Bardsley, secretary-treasurer. D. K. Holway then showed motion pictures depicting the construction of the Grand River Dam. Mr. Holway is the son of W. R. Holway, resident engineer on the project. The presentation of a certificate of life membership to Victor H. Cochrane concluded the meeting.

Oregon Section—*Portland, December 14:* A talk on "Earthquakes and Storms and the Red Cross Disaster Preparedness and Relief Plan for Multnomah County" was given by J. C. Stevens, consulting engineer of Portland. Next, there was a paper on "The Army Engineers' Cooperative Emergency Flood Plan for the Willamette Valley," which was given by a member of the Corps of Engineers. A talk on the flood fight at Louisville, Ky., during the flood of 1937 concluded the evening. This was given by Lt. Frank S. Besson, Jr.

Panama Section—*Panama City, December 4:* "Irrigation in Northern Mexico" was the subject of discussion at this meeting. The principal speaker was Howard P. Bunger, who went recently to the Canal Zone as chief of the section of structural concrete design. The officers for 1940, elected at this time, are R. L. Klotz,

president; T. B. Larkin, first vice-president; A. A. Mittag, second vice-president; and C. Morse, secretary-treasurer.

PHILADELPHIA SECTION—*December 12:* "The Use of Concrete in Europe" was the subject of discussion, the principal speaker being Arthur J. Boase, manager of the Structural and Technical Bureau of the Portland Cement Association. Preceding the technical program, Secretary Seabury presented certificates of life membership to fifteen members of the Section. In making these presentations Mr. Seabury gave a brief summary of the progress of the Society from 1898 to 1915, the period when the members receiving the certificates first joined the Society. William H. Gravell was in charge of arrangements.

ROCHESTER SECTION—*December 12:* A round table on building design was the feature of this occasion. R. R. Sheridan, assistant structural engineer for the Eastman Kodak Company, gave the principal talk—on concrete design, as it affects factory buildings.

SACRAMENTO SECTION—*December 5, 12, and 26:* The first of these was a business meeting. On the 12th F. N. Hveem, senior physical testing engineer for the State Division of Highways, gave an illustrated talk on the gradation of mineral aggregates. At the same session Arthur B. Foote was awarded a certificate of life membership. On the 26th Morgan E. Stewart, a Junior in the Section, discussed "The Sanitary Engineer's Triumph Over Disease." *Junior Forum, December 13:* Ray L. Walker spoke on amateur color photography.

ST. LOUIS SECTION—*December 9:* The annual election of officers resulted as follows: Harry F. Thomson, president; P. S. Reinecke and F. C. Woermann, vice-presidents; and Milton Buchmueller, secretary-treasurer. Ivan C. Crawford, dean of the school of engineering and architecture at the University of Kansas, delivered an address entitled "The Civil Engineer of the Future."

SAN FRANCISCO SECTION—*December 1:* A joint meeting with local groups of the Founder Societies. Following a dinner, a large group heard Dr. Gustav Egloff, director of research for the Universal Oil Products Company, speak on the topic, "Modern Motor Fuels—Their Production and International Significance." *December 19:* At this, the annual, meeting Willis C. Lowe, assistant airport engineer for the Pan-American Airways, described the construction of the company's bases on several of the islands in the Pacific. The annual election of officers resulted in the selection of Harold B. Hammill for president, and of Walter Dreyer and James I. Ballard for vice-presidents. Edward M. Knapik has been appointed secretary to fill the vacancy caused by the resignation of T. J. Corwin, Jr. *Junior Forum, November 21:* The topic scheduled for discussion was "Proposed New Activities for the Junior Forum," the principal speaker being Prof. Leon B. Reynolds, of Stanford University.

SEATTLE SECTION—*November 27:* Dinner was followed by a short business session. Then M. O. Sylliaasen talked on Seattle's sewerage system. Mr. Sylliaasen was consulting engineer on Seattle's new sewage disposal plant, the first to be constructed in the city.

SPOKANE SECTION—*December 13:* Joint meeting with the Associated Engineers of Seattle. The role of the Indian in road construction was discussed by Harold J. Doolittle, district highway engineer for the U.S. Indian Service. Motion pictures showing scenes of highway construction on the Colville Indian Reservation were then presented.

SYRACUSE SECTION—*January 8:* An illustrated lecture on the Ley Creek Sewage Treatment Plant was given by Glenn D. Holmes, director and chief engineer of the Onondaga County Sanitary Sewer and Public Works Commission. A long discussion followed. *January 8:* Ernest F. Robinson, chief engineer for the Maracaibo (Venezuela) Bar Commission, gave a short talk on the work that he is doing in connection with surveys for harbor improvement at Maracaibo. The group then adjourned to meet with the Syracuse Technology Club and hear Elon P. Stewart, of the Syracuse city engineering department, give an illustrated lecture on the Syracuse water supply system.

TACOMA SECTION—*December 13:* The following officers were elected for 1940: Bertram P. Thomas, president; Fred C. Dunham, vice-president; and Wells H. Ashley, secretary-treasurer. The speakers on the technical program were Edgar L. Warner, secretary-manager for the Harrison Pipe Company; C. M. Howard, engineer for the Concrete Pipe Manufacturers Association; and Homer M. Hadley, regional structural engineer for the Portland Cement Association. All discussed different aspects of the manufacture, testing, and usage of pre-cast concrete products.

TENNESSEE VALLEY SECTION—*Knoxville Sub-Section, December 5 and January 10:* C. E. Blee, project engineer on Hiwassee Dam, spoke at the first of these sessions, discussing methods used to control the dust in quarry crusher operations, which causes silicosis. There was more informal entertainment, too, in the form of tap dancing with piano accompaniment. At the January meeting a certificate of life membership in the Society was awarded to Alexander Bonnyman. The speaker was Harry Bauer, technical librarian for the Tennessee Valley Authority, whose subject was "Reading—the Engineer's Responsibility." *Chattanooga Sub-Section, December 19:* Gordon R. Clapp, general manager of the TVA, gave a progress report on the work of the Authority.

UTAH SECTION—*December 8:* The list of 1940 officers, elected at this time, is as follows: George D. Clyde, president; L. M. Winsor, first vice-president; George H. Taylor, second vice-president; and F. H. Richardson, secretary-treasurer. T. C. Adams, associate professor of civil engineering at the University of Utah, led a discussion with particular reference to conditions at the University of Utah. The members then went to the office and plant of the Lang Company in Salt Lake City to view several sound motion pictures covering recent developments in earth-moving equipment.

Student Chapter Notes

BROOKLYN POLYTECHNIC INSTITUTE—*November 16, 24, and 30:* The day section of the Brooklyn Polytechnic Institute Student Chapter made inspection trips on these dates. On the 16th the treatment plant of the Hackensack Water Company at Oradell, N.J., was visited in connection with a course in water supply. On the 24th the group went to Connecticut to inspect certain parts of the Merritt Parkway and its extension, which are still under construction. The trip on the 30th also supplemented the classroom course on water supply. On this occasion the members visited three units in the New York City supply system—a pumping station in the Bronx, Hillview Reservoir in Yonkers, and the Kensico Reservoir in Westchester County.

BROWN UNIVERSITY—*November 27 and December 8:* At the first of these sessions James S. Degnan delivered a paper on flood control in the Sacramento River valley. At the December meeting Nicholas Shmaruk, president of the Chapter, discussed the subject of labor unions.

GEORGIA SCHOOL OF TECHNOLOGY—*December 5:* At this banquet, which was held in honor of the new members, a talk entitled "A Business Man Looks at Civil Engineering" was presented by a local banker. Among the other guests of honor was Walter S. McDonald, retiring president of the Georgia Section.

NEWARK COLLEGE OF ENGINEERING—*December 11 and January 8:* William H. Smith, of the Civil Engineer Corps of the U.S. Navy, gave a résumé of the history of the Corps at the first of these sessions. The speaker at the January meeting was Charles Gilman, vice-president and general manager of the Massey Concrete Products Corporation, who gave an illustrated lecture on concrete piles.

PENNSYLVANIA STATE COLLEGE—*November 28 and December 12:* The program for the first meeting was furnished by the Association of American Railroads and consisted of the showing of two sound films, one illustrating the magnitude of the railroad industry and the other the competitive agencies available for freight transportation. The program for the second meeting was on steel construction and consisted of the showing of a number of slides furnished by the American Institute of Steel Construction. The slides were described by two members of the civil engineering staff.

SYRACUSE UNIVERSITY—*December 5:* The Chapter sponsored a get-together dinner meeting for the engineering students and faculty, which was attended by 30. Each student was asked to speak briefly on why he chose civil engineering for a profession. Various faculty members also spoke, as did Earl F. O'Brien, designing engineer for the Onondaga County Sanitary Sewer and Public Works Commission.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for March

Papers from the Annual Meeting will constitute a large part of the March issue, with those from the Waterways and Soils Mechanics Divisions probably predominating. Among the independent articles also expected to be included are a practical analysis of "The Hydraulics of Surface Runoff," by L. K. Sherman; a review of present knowledge of "Wind Pressure on Structures," by George E. Howe; interesting research in the highway field—"A Test of Highway Sign Visibilities"—by Miles S. Kersten; and an account of the original resurvey and recent retracing of the north boundary of Wyoming Territory, by William R. Bandy.

Joint Conference on Standard Construction Contracts Reorganized

Reorganization of the Joint Conference on Standard Construction Contracts, inactive for several years, was completed in Washington, D.C., on December 15–16 with the selection of J. W. Cowper, M. Am. Soc. C.E., as chairman, Thomas H. Urdahl as secretary, and H. E. Foreman as executive secretary. A study of construction contract procedure was embarked upon, and a call will soon be made for a second meeting in Washington some time in February or March.

The Joint Conference, first organized 15 years ago, performed valuable work in bringing about a standardization of the general conditions of contract forms. It developed a standard form of engineering contract, gave valuable counsel in perfecting the standard building contract form, and was instrumental in bringing about standardization of federal construction contract forms. In the past few years it has been inactive due chiefly to economic conditions of the country. Now the need is seen for a continuing study looking forward to development of recommendations calculated to keep constructing contracting procedure abreast of changing conditions.

The December meeting was called by Edward J. Harding, managing director of the Associated General Contractors of America. The A.G.C. brief prepared for conference consideration made certain recommendations for changes, outlined situations deemed in need of correction, and outlined practices not within the scope of contract documents in which remedies could be made. The A.G.C. recommended an emergency clause for public and private contracts which would provide that, in case the President declared an emergency, contractors would be reimbursed for delays and increased costs caused by the emergency, and would provide an appropriate procedure for termination of contracts. It also recommended that on public work contractors be reimbursed for delays caused by government action, and that procedure of the U.S. Engineer Corps be followed in requiring owners to pay taxes assessed after the contract had been awarded.

Contract or specification provisions which have arisen and seem in conflict with sound procedure were outlined as those which require contractors to guarantee specified methods and the results; the refusal of owners to guarantee elevations or borings shown on plans; "catch-all" clauses which make contractors responsible for mistakes on plans; and authorization for owners to dispense contractors' funds. Outside the scope of contract documents, the A.G.C. outlined procedures between contractors, architects, and engineers, where standardization of practices would improve conditions and tend to reduce costs. Consideration was also asked for a standard procedure where a delayed final payment is much greater than the value of the work in dispute.

The conference is composed of official representatives from the American Association of State Highway Officials, American Engineering Council, American Institute of Architects, American Railway Engineering Association, American Society of Civil Engineers, American Water Works Association, Western Society of Engineers, and the Associated General Contractors of America. Ezra B. Whitman is the official representative of the Am. Soc. C.E., while Mr. Cowper, though a member of the Society, officially represents the A.G.C. Other Society members among the representatives are H. K. Bishop, L. G. Lenhart, and Chester L. Post.

"Contact!"

A membership booklet recently issued by the Cleveland Engineering Society and entitled "Contact!" carries on its inside front cover a most forceful presentation of the importance to an engineer of affiliating with a professional organization. It is reproduced here by permission of the manager of that society, who states that its author is T. H. Holcomb of the Ohio Bell Telephone Company:

" 'Contact!' As the pilot calls out to the mechanic, he experiences a sense of impending fulfilment. He is about to fly, and he realizes, perhaps subconsciously, that behind that one word 'contact!' are all the resources of science; that the dreams of inventors, the thousands of hours of research by engineers, the years of patient work by designers, the ingenuity of craftsmen in building his ship, and his own careful, thorough preparation are about to culminate in flight. He needs only to make that contact, start the motor, and immediately the soaring swiftness of birds is his to take him wherever he wills—but he must make that contact, for without it his ship would remain a clumsy, useless thing and science would have produced it in vain.

"Contact is equally important to the engineer. Without the stimulation, the information, the opportunities, and the vision which contact with engineers in his own and other fields gives him, he will find that his years of education, research, and experience are of relatively little use to him. If he neglects to keep in touch with the personnel of the engineering world, then the efforts of science and education in producing an engineer will have been of little avail. . . .

" 'Contact!' "

Prof. N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

THIS month "Civil Engineering" introduces to its readers that famous mental gymnastician, Prof. N. G. Neare. His faithful scribe, Mr. Rowe, has agreed to keep us posted on his exploits as thoroughly as possible; but as the professor frequently wanders off on extended trips without even Mr. Rowe to accompany him, reports of his activities from any reader who may encounter him will be most welcome. They may be addressed to Society Headquarters, and will be forwarded promptly to Mr. Rowe.

Professor Noah Goode Neare, better known to his students as "N. G." Neare, claims to have given new inspiration to two despondent polar explorers who were recent guests at the Engineers Club. Overhearing their conversation, he learned that one was Hans Tuck, young and ambitious and with a polar complex, while his older friend was none other than Haddah Nipp, notorious for his daring but fruitless East Pole expedition.

Professor Neare interrupted to point out the fallacy of such expeditions. "The North Pole was found by going as far north as possible and the South Pole by going as far south as possible. But you, Mr. Nipp, tried to go as far east as possible, which is impossible, as you soon realized after having circumnavigated the globe 41 times. Explorers should confine their ambitions to possibilities, and leave impossibilities for the engineers, who are used to doing such things."

"Then you advise against further polar searches?" Nipp asked.

"By no means. On the contrary, I heartily recommend an expedition to the Northeast Pole. Take your young friend, Tuck with you, start from the equator at the Greenwich Meridian, head your plane northeast at, say, 100 miles per hour, maintain a northeast course until you

can't go farther northeast—and there you will be. I guarantee such a course will never return you to your starting point."

Gratitude and eagerness spread over the faces of Nipp and Tuck as they turned together for an animated whispering. It took them only a minute to come to a decision that Nipp announced. "As each of us has his own plane, I will seek the Northeast Pole while Hans hunts the Northwest Pole, thus going you one better. So that we may estimate fuel and food requirements, can you tell us how long it will take to get there?"

Now it didn't take the professor a month to reply, but his answer is being held until the next issue to permit any reader to cross slip-sticks with him. Confidentially, he took the earth to be a sphere with a radius of 3,956 miles, and 100 miles per hour as the ground speed of each expedition.

New Award Program Announced by Lincoln Foundation

A TWO-AND-A-HALF-YEAR program of scientific study, which will culminate in payment of $200,000 in awards, was announced last month by the James F. Lincoln Arc Welding Foundation.

The 458 awards are established for studies bringing out benefits of a social, economic, or commercial nature, such as reduction or elimination of hazards to safety and health, greater availability of comforts and conveniences through reduced prices, greater utility and durability of machines and structures, as well as industrial benefits such as cost savings and other advantages in manufacture, fabrication, or construction.

The awards range from $13,700 to $100, and embrace the following 12 classifications and 46 divisions:

Automotive: Engines or Engine Accessories; Bodies or Body Accessories; Frames or Frame Accessories; Trailers.

Aircraft: Engines or Engine Accessories; Fuselages or Fuselage Accessories.

Railroad: Locomotives; Freight Cars; Passenger Cars; Locomotive and Car Parts.

Watercraft: Commercial; Pleasure.

Structural: Buildings and Similar Structures; Bridges; Houses; Miscellaneous.

Furniture and Fixtures: House; Office.

Commercial: Commercial Welders or Job Shops; Garages or Service Stations.

Containers: Contents Stationary (Tanks, etc.); Contents Moving (Pipe Lines, etc.)

Welderies: Commercial Welderies; Plant Welderies.

Functional Machinery: Metal Cutting; Metal Forming; Electrical; Prime Movers; Conveying; Pumps and Compressors; Businesses; Functional Machinery not otherwise classified; Jigs and Fixtures; Parts of Functional Machinery.

Industry Machinery: Processing; Construction; Petroleum; Steel Making; Farming; Household; Food Making; Textile and Clothing; Printing; Industry Machinery not otherwise classified.

Maintenance: Machinery and Mechanical Equipment, including truck, bus, and taxi fleets; Structures and other applications for arc welding in maintenance such as pipe lines, railroad tracks, bridge strengthening, etc.

Participation in the Progress Program is open to everyone who plays any part in actually bringing about progress in the executive, design, fabrication, manufacture, construction, or maintenance phase of industrial product or structure development. Authors of studies may be executives, engineers, designers, architects, draftsmen, plant superintendents, production managers, foremen, proprietors of automotive garages or service stations, owners and operators of fabricating and repair shops, or any other person engaged in the various phases previously mentioned. One author, or a group of authors may submit a study. Any company or concern may submit more than one study, provided each is on a different subject and is prepared and submitted by a different author or group of authors.

Studies may bring out any and all social, scientific, economic, and commercial benefits which attest progress in industrial development. Studies must, however, report progress which can be attributed to application of the electric arc process of welding within the $2^1/_2$-year period, January 1, 1940, to June 1, 1942. Such progress may involve one of the following: (*a*) redesign and manufacture or construction of an existing machine, structure, building, manufactured or fabricated product of ferrous or non-ferrous metals; (*b*) new design and manufacture or construction of a machine, building, etc., as in (*a*); (*c*) organization, development, and conduct of a welding service; (*d*) development, planning, and performance of maintenance or repair work with arc welding.

Participants in the Progress Program have $2^1/_2$ years—from January 1, 1940, to June 1, 1942—to pursue their studies and prepare a report summarizing them. All those planning to qualify should record, for future reference, data in the form of designs, charts, photos, notes, and other pertinent information on operations as of December 31, 1939.

All inquiries concerning the award program should be addressed to the Secretary, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

More Books on Boulder Canyon Project

TWO MORE of the proposed series of 41 bulletins descriptive of the Boulder Canyon Project were recently published by the Bureau of Reclamation. These bulletins bear the general title, "Boulder Canyon Project Final Reports, Part V—Technical Investigations."

Bulletin 3 of this series (402 pages), entitled "Model Tests of Boulder Dam," presents the results of laboratory researches made to check the office analyses of load distribution, deflections, and stress conditions for semi-final designs of the dam. Deflection, strain, and stress data are given for flow, temperature, and various live-load tests of both models, and comparisons of test data with trial-load analyses of the model structures are also included.

Bulletin 4 (286 pages), "Stress Studies for Boulder Dam," presents the results of trial-load analyses and non-linear stress calculations made in developing the final design of the dam. The volume includes spreading of canyon walls, stress conditions in the canyon floor, deformations of the reservoir bed, and local stress concentrations in the dam.

In cloth covers these volumes sell for $2 each, and in paper binding for $1.50 (10% higher outside the United States). Orders, accompanied by a money order, should be addressed to the Bureau of Reclamation at either Denver, Colo., or Washington, D.C.

Comprehensive Report on Engineering Education Published by E.C.P.D.

THAT THE engineering school has fought its way upward and stands today on the level of the university and, in some cases, even on a higher level, is the general theme of the report on "Present Status and Trends of Engineering Education in the United States," by Dr. Dugald C. Jackson, emeritus professor at M.I.T., issued recently by the Engineers' Council for Professional Development, with the aid of funds supplied by the Carnegie Foundation for the Advancement of Teaching. The report is one of the valuable by-products of the task of accrediting curricula in engineering that has been accomplished during the last few years by the Committee on Engineering Schools of E.C.P.D.

In the early chapters of the report Dr. Jackson traces the history of developments that led up to the accrediting program, and sketches briefly the status of engineering education in America in 1939. He next turns his attention to the Committee on Engineering Schools of E.C.P.D., to the procedure it adopted in its task of accrediting curricula, and to comments on some of the perplexing problems it had to face and the progress of the committee's own thinking and methods that resulted from actually coming to grips with these problems.

The data themselves, which cover 679 curricula in 139 institutions, assembled, coordinated, and analyzed in the form of tables and charts, with Dr. Jackson's comments on what they signify to him, occupy the third portion of the report. These data, though gathered for the purpose of the accrediting program, constituted such a rich store of information of value to engineers and educators that the committee was able to secure from the Carnegie

Foundation for the Advancement of Teaching the funds necessary to put them in shape for public use.

As to the present status, Dr. Jackson provides a convenient summary in the following passages quoted from the report:

"It is reasonable to say that the majority of the substantially 160 engineering schools in the United States are now in a sound status and are wide-awake to improve their effectiveness. The principal defects in the quality of faculties are perhaps a lack of recognition of the unity of learning in science and in political economy as applied in engineering, an inadequate espousal of professional ideals as distinguished from either craftsmanship or speculative philosophy, a failure to impress on all students that a successful engineer's life demands continuous study throughout its length, and a failure to dovetail the curricula into political economy on one side as thoroughly as they are dovetailed into physical science on the other. . . .Part of the onus for the defects named may be appropriately laid at the doors of administrative officers. . . . There is an additional fault. . .which is the failure to recognize that the proper use of research vitalizes all levels of engineering education, from the sophomore undergraduate level to the most advanced levels, which makes it a requisite and important factor in such education.

"There are some critics who sigh over the state of engineering education and propose forcing modifications of its processes or of its duration by legislation in the states. They, however, usually visualize only some of the aspects of engineering practice (such, for example, as independent practice as a consultant), and they would make preparation for all the varied characteristics of engineering by means of one mold. Such proposals are false to the needs of the nation and its industries. The proponents sometimes argue from apparent analogies with the professions of medicine and law, but fail to yield thought to the vast difference in the scope of engineering activities compared with medicine and law, and therefore the wider variety of education that should be available without regimentation for practitioners in the various aspects of engineering. The evolution of engineering education over a variety or range of undergraduate and graduate curricula has occurred to meet the needs of the nation, and evolutionary changes are constantly under way as the needs of the nation's population and its industries change and the enlarging disclosures from scientific research make practicable. If the existing lag between the precepts and the fittingness of economic tenets, the vision of social relations and the ethics of political science can be overcome, the rate of evolution referred to will be accelerated naturally, but this cannot now be foreseen with definiteness . . . ."

With respect to students, Dr. Jackson comments on trends in selection and selective methods, "more steadfastly and judiciously" dispensed financial aid, "honors seminars in junior and senior year," association with teachers in laboratory work of a research character, slowly widening interest in "examinations of truly comprehensive character" and the "reduced emphasis on term examinations in individual subjects," and more stimulating textbooks.

There is, he points out, increasing interest in student meetings of the national engineering societies and a "tendency to carry on experiments in education and research in which more than one department takes an active interest." An impressive trend lies in the recently developed attention to the social relations of engineering and the social responsibilities of engineers, coupled with a swing from "practical empiricism to sound science." The change in attitude toward instruction in English "has been almost revolutionary," and there appears to be some evidence of a return to the study of foreign languages. The importance of economics and sociology "as subjects for close and accurate study by engineering students" is noted and discussed by Dr. Jackson.

The list of trends is completed with observations on "institutional jealousies" which are said to be "softening" and are being replaced by cooperation and the elimination of duplication of men and equipment. "Ultimately," Dr. Jackson observes, "the engineering schools may reclassify themselves on segments determined by the ability (with their several locations and financial means) to minister best to students of various ambitions," thus laying the foundation for elimination of duplications and concentrating on different work where it can best be dealt with. "Unhappily," he continues, "a trend now exists which disturbs the balance instead of improving it. This is the tendency of technical institutes to change into the scope of degree-granting engineering schools. The need in the engineering field is not for fewer students in the aggregate of those who are preparing for the engineering trades; but the need is for better-sifted engineering students in the engineering schools and an increased proportion of technical-institute students looking forward to the engineering trades."

Engineers in the Public Eye

It has often been said that engineers should "talk" as well as "write." In this connection the October issue of *Mechanical Engineering* presents an article by Joseph M. Byrne, Jr., entitled "The Engineer in Public Service," which states how the engineer can influence his city or community.

"Get Acquainted!" is the first counsel. Learn the viewpoint of your neighbors. Their opinions, though different from yours, may help you to see the situation more clearly. Become acquainted with your local and state representatives. You may find that the Board of Education in your district harbors excellent members who inspire confidence and deserve your support; perhaps you will see a need for change.

"Educate Yourself!" Keep informed of local problems under consideration so that you may have the complete data before expressing an opinion. Find out what your city or community has done about planning, housing, safety, or law enforcement. You will discover that association with civic associations is often broadening as well as informative.

"Effective public understanding cannot be realized by a mere handful of broadly educated men," says Mr. Byrne, "there must be not only those who serve the general welfare directly in their stated capacities, but untold others who, as citizens possessed of higher education, will give critical thought and support to measures initiated for the public good." It is the engineer in public service who can help his city or community to a greater understanding of efforts made toward civic betterment.

Mr. Byrne also summarized the objectives of the Committee on Professional Objectives of the American Society of Civil Engineers and stated that with them "the members of the American Society of Mechanical Engineers should be in hearty accord."

Brief Notes from Here and There

It is expected that among the forthcoming publications of the Department of Agriculture will be included compilations of hydrologic data from small watersheds at nine of the Soil Conservation Service's Conservation Experiment Stations. These publications will include rainfall, surface runoff, and soil-loss data for the period 1931 to date, obtained from small watersheds subjected to various cover and land use. A recent act of Congress prohibits the distribution of government publications to any individual who has not expressed in writing a desire for such publications Monthly lists of Department of Agriculture publications may be obtained, however, by writing to the Office of Information, Department of Agriculture, Washington, D.C., and any publication so listed will be mailed upon receipt of a written request.

* * * *

New Year's resolutions should have been easy this year for Society Member Albert Frederick Porzelius, of Chattanooga. It is reported that he became a father for the first time at just 30 seconds past midnight on January 1.

NEWS OF ENGINEERS

Personal Items About Society Members

Clarence W Dunham formerly assistant engineer in the design division of the Port of New York Authority, has become chief structural designer for the Phelps Dodge Corporation, of New York. Mr. Dunham will take charge of the structural design work for the company's new copper smelting plant at Morenci, Ariz.

D. MCGREGOR WILLIAMS, assistant superintendent of the Durham (N.C.) water department, has been appointed superintendent of the department.

CHARLES ASH, division engineer for the Ohio State Highway Department at Lima, Ohio, has been named assistant city engineer of Lima.

WALDO G. BOWMAN, for fifteen years a member of the editorial staff of *Engineering News-Record*, has been appointed co-editor of that publication.

GEORGE H. DUGGAN, chairman of the Board of the Dominion Bridge Company, Ltd., and the Dominion Engineering Works at Montreal, Canada, has been made an honorary member of the Canadian Engineering Standards Association. Mr. Duggan is also an Honorary Member of the Society.

FRANK L. RASCHIG, previously division engineer for the Ohio State Highway Department, has been made state director of the Ohio State Department of Public Works.

C. F. IZZARD, assistant engineer for the Public Roads Administration, stationed at Austin, Tex., has taken a year's leave of absence to do graduate work in hydraulics at the University of Iowa.

J. W. KELLY is now professor of civil engineering at the University of California. Until lately, he was research engineer in the Engineering Materials Laboratory at the university.

DECEASED

JOHN GABRIEL ALEXANDROFF (M. '27) chief engineer of the Lower Volga Irrigation Project and Development, Moscow, U.S.S.R., died some time ago, though word of his death just reached Society Headquarters. He was about 60 at the time of his death. Mr. Alexandroff spent a number of years on bridge and dam construction in Russia, and from 1912 to 1918 was similarly employed in Turkestan. For several years, also, he was lecturer at the Petersburg Polytechnical College for Women and at the Petersburg Technological Institute.

HERMAN LEONARD ARBENZ (M. '27) consulting engineer of Ravenswood, W.Va., died on November 15, 1939. He was 65. From 1905 to 1910 Mr. Arbenz was engineer for Ohio County (West Virginia) in charge of all road work; from 1912 to 1916, senior highway engineer for the U.S. Bureau of Public Roads; and from 1924 to 1929, city engineer of Wheeling, W.Va. From the latter year on he served various municipalities, specializing in slip and drainage problems.

EVERETT N. BRYAN (M. '25) supervising hydraulic engineer for the division of water resources of the California State Department of Public Works, died at his home in Sacramento, Calif., in December 1939. Mr. Bryan, who was 55, had been connected with the State Department of Public Works since 1920. Prior to that he was engaged in irrigation and hydraulic work in Washington and California—for four years as chief engineer of the Waterford (Calif.) Irrigation District. Mr. Bryan was one of the founders of the Sacramento Section of the Society, which he served as president.

RALPH EDWARD GOODWIN (M. '35) associate professor of civil engineering at the College of the City of New York, died suddenly at the conclusion of his classes on December 16, 1939. He was 53. Early in his career Professor Goodwin taught at Yale and at Columbia, and from 1913 to 1922 was connected with various organizations, including the U.S. Shipping Board. In 1922 he went as instructor to the College of the City of New York, where he was a leader in student activities and instrumental in furthering Student Chapter work.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

WILLIAM CHAUNCEY HAWLEY (M. '02) vice-president and superintendent of the Pennsylvania Water Company, Wilkinsburg, Pa., died at his home in Edgewood, Pa., on December 10, 1939. He was 74. From 1886 to 1893 Mr. Hawley was assistant for Chester B. Davis, and from 1896 to 1902 engineer and superintendent of the Atlantic City (N.J.) Water Department. In the latter year he became connected with the Pennsylvania Water Company, which he served for many years as chief engineer.

BYRON HOUGHTALING (M. '37) division engineer for the New York City Board of Transportation, was stricken with a fatal heart attack on December 19, 1939, while addressing an audience on the construction of the Sixth Avenue (New York) subway, of which he was chief engineer. Mr. Houghtaling, who was 49, had served with various state and city engineering departments for thirty-two years—since 1924 with the Board of Transportation. As division engineer, he was in charge of all subway construction in Manhattan.

ARTHUR SYLVANUS KEMMAN (Assoc. M. '29) hydrographer for the Los Angeles County Flood Control District, died on October 31, 1939, at the age of 52. From 1919 to 1921 Mr. Kemman was marine inspector for the Union Oil Company, and from 1922 to 1925 draftsman for the Southern California Edison Company. In the latter year he became draftsman for the Los Angeles County Flood Control District. During the war he was a lieutenant in the U.S. Naval Reserve Force, stationed at the U.S. Navy Yard at Bremerton, Wash.

PHILIP GEORGE LANG, JR. (M. '21) engineer of bridges for the Baltimore and Ohio Railroad, Baltimore, Md., died on December 9, 1939, at the age of 56. In 1907—after a brief period with the American Bridge Company and the South and Western Railroad—Mr. Lang began his long connection with the Baltimore and Ohio Railroad. Interested for many years in the affairs of the Society, he served as president of the Maryland Section in 1935 and 1936 and, at the time of his death, was active on several of the Society's Technical Division committees.

EVERETT WILSON LEWIS (M. '01) of Wellesley, Mass., died on December 9, 1939, at the age of 85. Mr. Lewis' early career was largely in the field of railroad work—he held several positions with the Northern Pacific Railroad and, from 1906 to 1914, was assistant engineer for the New York, New Haven, and Hartford Railroad. In 1918 Mr. Lewis became connected with the United Electric Company of Springfield (Mass.), where he remained until his retirement in 1932.

GEORGE JOHN LYON (M. '14) of Washington, D.C., died at Parkersburg, W.Va., on December 17, 1939, at the age of 65. From 1904 to 1910 Mr. Lyon was professor of civil engineering at Colorado College, where he organized the civil engineering department and installed hydraulic and material-testing laboratories. In the latter year he joined the civil engineering staff at Union College, remaining there for a number of years. From 1912 on he, also, served as assistant engineer in the Albany (N.Y.) office of the U.S. Geological Survey.

CHARLES DAVID MARX (M. '96) Past-President and Honorary Member of the Society, died at Palo Alto, Calif., on December 31, 1939, at the age of 82. A sketch of his career appears in the "Society Affairs" department of this issue.

WILLIAM FRANKLIN MILLER (Assoc. M. '16) engineer of maintenance of way for the Eastern Pennsylvania Division of the Pennsylvania Railroad, Harrisburg, Pa., died at Ardmore, Pa., on December 18, 1939. He was 59. Mr. Miller's entire career was spent with the Pennsylvania Railroad, with which he became connected in 1903. During this long period he served in various capacities in different parts of the East, and in 1926 he was promoted to the position of engineer of maintenance of way for the Eastern Pennsylvania Division.

PAUL NASH (M. '15) engineer and general contractor of Stamford, Conn., died in that city on December 23, 1939. In 1899 Mr. Nash became city engineer of Stamford, leaving one year later to go into private practice. In 1902 he was re-employed as city engineer and remained in this capacity for over twenty years. In 1908 he was also made city superintendent of public works.

ALBERT WOODBRIDGE PIODA (Assoc. M. '12) president of the Berkeley Hillside Properties Company, San Francisco, Calif., died at his home in Berkeley, Calif., on April 27, 1939. He was 60. Mr. Pioda held several positions on the West Coast, including that of city engineer of Redwood

City (1911 and 1912) and superintendent of the Redwood City Harbor Company (1913 to 1918). Later he was a captain in the Corps of Engineers of the U.S. Army and, for some years, maintained a private practice in San Francisco.

Emile Leonard Rimbault (Assoc. M. '19) for the past two years manager of sales for the federated metals division of the American Smelting and Refining Company, New York City, died on December 22, 1939. He was 45. Before assuming his connection with this organization Mr. Rimbault for a number of years occupied a similar position with the Federated Metals Corporation in New York. Prior to that he was with Post and McCord, and with the Edward F. Terry Manufacturing Company.

Edson Mason Scofield (M. '05) construction engineer of Los Angeles, Calif., died at his home there on December 28, 1939, at the age of 72. From 1894 to 1901 Mr. Scofield was with the Youngstown Bridge Company. He then formed an engineering partnership with his brother in Philadelphia, serving as president of this firm until 1918. From the latter year until 1922 he was president of the Pacific Marine and Construction Company at San Diego, Calif. He then resumed his connection with the Scofield Engineering-Construction Company, his headquarters being in Los Angeles.

Howard Platt Treadway (M. '16) until recently president and treasurer of the Kansas City (Mo.) Bridge Company, died at his home in that city on December 26, 1939. Mr. Treadway, who was 65, became connected with the Kansas City Bridge Company in 1902, serving as engineer until 1926 and as president and treasurer from then on until his retirement last year. During this latter period Mr. Treadway was, also, president and director of the Kansas City Crushed Stone Company. He was one of the principal benefactors of the University of Kansas City.

Rudolph Peter Johann Tutein-Nolthenius (M. '99) died at his home at La Tour de Peilz, Switzerland, on November 27, 1939. Mr. Tutein-Nolthenius, who was 88, was a native of Holland, where he spent his entire professional life. From 1874 to 1902 he was Dutch state engineer, and from 1903 to his retirement in 1920 he was president of the Royal Commission for the Dutch Middle Classes.

John Harold Winter (M. '26) hydraulic engineer for the PWA on the Santee-Cooper Project at Charleston, S.C., died on January 2, 1940, at the age of 54. Mr. Winter's major engineering connections included work as chief engineer for the Federal Power Company at Anniston, Ala., and as hydraulic engineer for the Electric Bond and Share Company, of New York, which he represented in Brazil. More recently he was with the U.S. Forest Service in connection with the design and construction of hydraulic structures in eleven states and Puerto Rico.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From December 10, 1939, to January 9, 1940, Inclusive

Additions to Membership

Abbott, Robinson (Assoc. M. '39), Asst. Prof., Civ. Engr., Bucknell Univ. (Res., 725 Market St.), Lewisburg, Pa.

Ackerman, Samuel Morris (Jun. '39), Engr., U.S. Grazing Service, CCC, Dept. of Interior, Camp Hubbard Ranch G-108, Wells, Nev.

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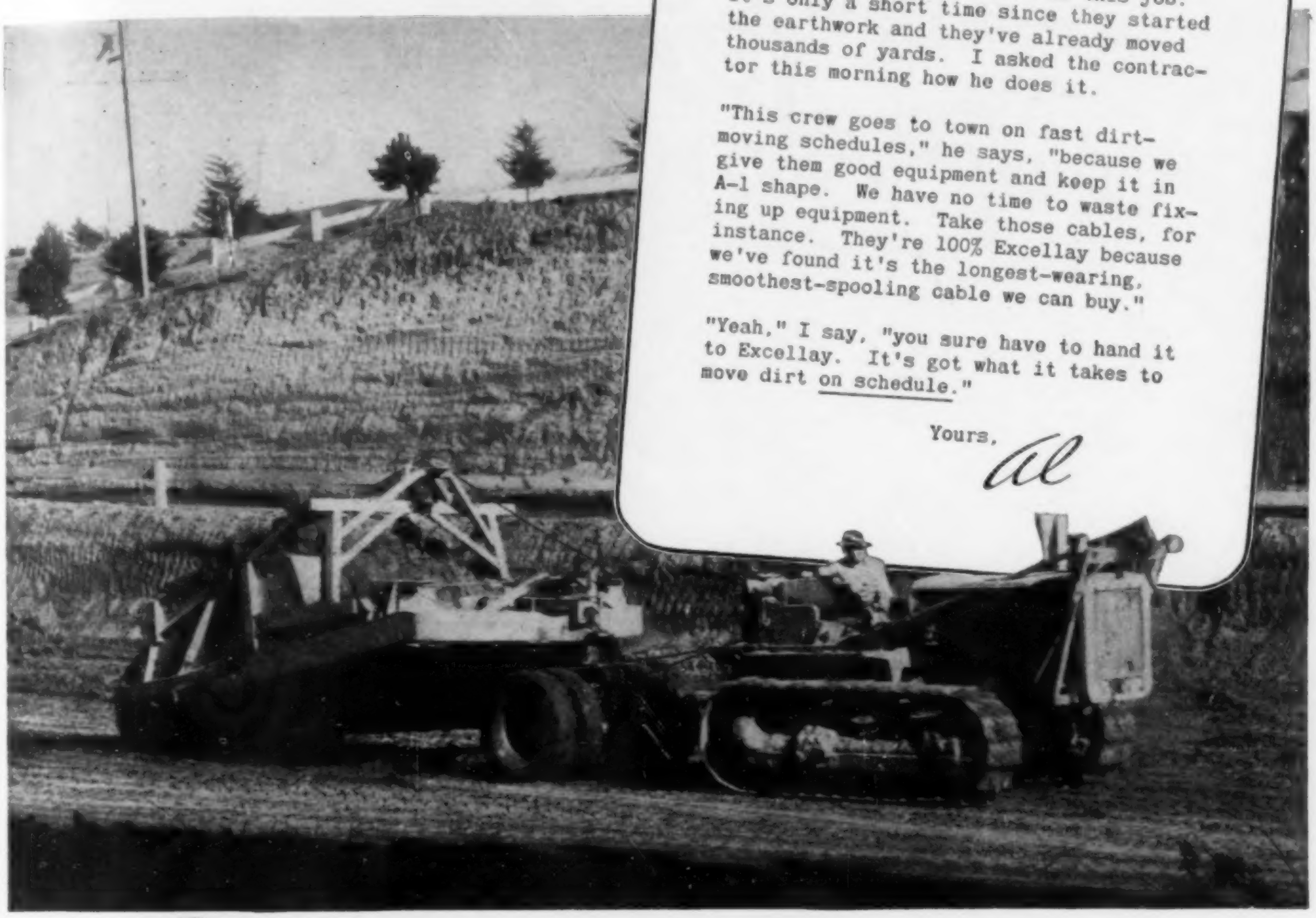

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JOHNSON, THEODORE SEDGWICK (Jun. '12; Assoc. M. '13; M. '39), Prof. of Industry, North Carolina State Coll.; Chf. Engr., State Dept. of Conservation and Development, New State Office Bldg., Raleigh, N.C.

MCNOWN, WILLIAM COLEMAN (Assoc. M. '21; M. '39), Engr., Douglas County Kaw Drainage Dist. (Res., 1734 Illinois St.), Lawrence, Kans.

MARTINE, FRANKLIN ARCHIE (Jun. '36; Assoc. M. '39), Asst. Office Engr., International Boundary Comm., San Benito, Tex.

MONNING, JOHN CHESTER (Jun. '33; Assoc. M. '39), Structural Engr., City of Los Angeles, City Hall (Res., 118 South Manhattan Pl.), Los Angeles, Calif.

OSGOOD, ELMER CLAYTON (Jun. '28; Assoc. M. '39), Junior Civ. Engr., U.S. Forest Service, Camp S-93, CCC, Box 294, Stockbridge, Mass.

PENNOCK, LEWIS "DOCK" (Jun. '31; Assoc. M. '39), Junior Designing Engr., Bridge Div., State Highway Dept., Highway Bldg., Austin, Tex.

ROSA, JOSEPH JOHN (Jun. '31; Assoc. M. '39), Junior Engr., U.S. Engr. Office, 2d New Orleans Dist., Foot of Prytania St., New Orleans, La.

SCHWARTZENHAUER, ARTHUR GEORGE (Jun. '35; Assoc. M. '39), Transitman, Bureau of Highways, Coeur d'Alene, Idaho.

SWITZER, JACOB WADE (Jun. '28; Assoc. M. '39), With Chicago Bridge & Iron Co., 1305 West 105th St. (Res., 10250 South Wood St.), Chicago, Ill.

TORRE, MARIO DE LA (Jun. '37; Assoc. M.'39), Field Engr., South American Gulf Oil Co., Box 294, Barranquilla, Colombia.

WARNOCK, JACOB EUGENE (Jun. '28; Assoc. M. '31; M. '39), Hydr. Engr., U.S. Bureau of Reclamation, 406 Custom House, Denver, Colo.

REINSTATEMENTS

BUTLER, WILLIAM PARKER, M., reinstated Jan. 2, 1940.

DAVIDSON, LEO, Jun., reinstated Jan. 4, 1940.

FERNANDEZ, MIGUEL ANGEL, Jun., reinstated Jan. 5, 1940.

HALPIN, JOHN FRANCIS, Assoc. M., reinstated Jan. 2, 1940.

HERSEY, THEODORE SCHUYLER, Assoc. M., reinstated Jan. 1, 1940.

KUNTZ, GUY THEODORE, M., reinstated Jan. 2, 1940.

KURZ, ERNST WILLIAM, Assoc. M., reinstated Jan. 1, 1940.

LONG, CLARENCE BURTON, Assoc. M., reinstated Jan. 1, 1940.

LUNDGREN, GUSTAF HARALD, Assoc. M., reinstated Jan. 1, 1940.

SCOTT, JOHN DEAL, Jun., reinstated Jan. 5, 1940.

RESIGNATIONS

BALDWIN, WILLIAM HENRY, Assoc. M., resigned Dec. 31, 1939.

BLOG, LEON, Assoc. M., resigned Dec. 31, 1939.

BOGVAD-CHRISTENSEN, VILHELM, Assoc. M., resigned Dec. 31, 1939.

BOWMAN, FREDERIC BERKELEY, Assoc. M., resigned Dec. 31, 1939.

BRAND, HARRISON, JR., Assoc. M., resigned Dec. 31, 1939.

BROWN, CHARLES ELLSWORTH, Assoc. M., resigned Dec. 31, 1939.

BUCK, EDWARD CLARKE, M., resigned Dec. 31, 1939.

BURGESS, C. CALVIN, M., resigned Dec. 31, 1939.

CADY, LOWELL, Assoc. M., resigned Dec. 31, 1939.

CARRIER, VIRGIL SAMPSON, Assoc. M., resigned Dec. 31, 1939.

CARROLL, ROGER MERLE, Jun., resigned Dec. 31, 1939.

CARSWELL, CHARLES, Assoc. M., resigned Dec. 31, 1939.

CATTIE, NICHOLAS JULIUS, Jun., resigned Dec. 31, 1939.

CLARK, LINWOOD LEBOEUF, Jun., resigned Dec. 31, 1939.

CORTELYOU, JOHN TAYLOR, Jun., resigned Dec. 31, 1939.

DEWITT, JOHN ELLINGWOOD, Assoc. M., resigned Dec. 31, 1939.

DUKES, WILLIAM WEAVER, Jun., resigned Dec. 31, 1939.

DUPUY, BEN FRANCIS, M., resigned Dec. 31, 1939.

EITELBERG, SIDNEY, Jun., resigned Dec. 31, 1939.

FEWSMITH, WILLIAM LEE, Assoc. M., resigned Dec. 31, 1939.

FORD, CURRY ELLISTON, Jun., resigned Dec. 31, 1939.

FRENCH, CHARLES HOTTEL, Jun., resigned Dec. 31, 1939.

FREIBERG, CHARLES AUGUSTUS, Assoc. M., resigned Dec. 31, 1939.

GORDON, SAUL CANTOR, Assoc. M., resigned Dec. 31, 1939.

GREEN, EARL, Assoc. M., resigned Dec. 31, 1939.

HAGERTY, JOHN JOSEPH, Affiliate, resigned Dec. 31, 1939.

HARLAN, CLARENCE HALLER, Assoc. M., resigned Dec. 31, 1939.

HAWLEY, JOHN CHURCH, Assoc. M., resigned Dec. 31, 1939.

HEALD, JAMES HUGHES, M., resigned Dec. 31, 1939.

HEBERT, GREGORY MACDONALD, Jun., resigned Dec. 31, 1939.

HEGY, WILLIAM ZOLTON, Jun., resigned Dec. 31, 1939.

HOWELL, ROBERT PHILIP, M., resigned Jan. 3, 1940.

HURD, CHARLES HENRY, M., resigned Dec. 31, 1939.

HYLLAND, EINAR NYSOM, Jun., resigned Dec. 31, 1939.

INTEMANN, HENRY LUTHER, Assoc. M., resigned Dec. 31, 1939.

JACKSON, WILLIAM, Assoc. M., resigned Dec. 31, 1939.

KEASBEY, HOWARD BUZBY, Assoc. M., resigned Dec. 31, 1939.

KEENAN, WILLIAM HENRY, JR., Jun., resigned Dec. 31, 1939.

KERR, DUNCAN JOHN, M., resigned Jan. 8, 1940.

KERR, WILLIAM WAVERLEY, JR., Jun., resigned Dec. 31, 1939.

KING, ROBERT CALLEN, Assoc. M., resigned Dec. 31, 1939.

KNOWLTON, STEPHEN BAILEY, M., resigned Dec. 31, 1939.

KRUGER, HERMAN AUGUST, M., resigned Dec. 31, 1939.

LA DU, DWIGHT B., M., resigned Dec. 31, 1939.

LOGAN, CHESTER RUSSEL, Assoc. M., resigned Dec. 31, 1939.

LOTT, HARRY CHICKALL, M., resigned Dec. 31, 1939.

LOWERY, JOHN, Assoc. M., resigned Jan. 5, 1940.

MCCORMICK, FRANK JAMES, Jun., resigned Dec. 31, 1939.

MCGEHEE, CHARLES BURNAM, Assoc. M., resigned Dec. 31, 1939.

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Underground or on the surface, they ep whittling at your overhead with ir low consumption of low-cost fuel . their tremendous pushing and pull- power . . . the ruggedness that lets em keep going, 24 hours a day if cessary . . . their ability to handle ny angles of every job . . . and their edom from excessive maintenance- pairs which not only saves you tual money, ***but time that's*** *orth money!*

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MARKL, ARTHUR RICHARD CORBINIAN, Assoc. M., resigned Dec. 31, 1939.

MERCER, LESLIE BOYD, Assoc. M., resigned Dec. 31, 1939.

MODAK, BHASKAR LAXMAN, M., resigned Dec. 31, 1939.

REDINGTON, THOMAS GREGORY, Assoc. M., resigned Dec. 31, 1939.

ROBERTS, WARREN RUSSELL, M., resigned Dec. 31, 1939.

ROSE, EUGENE LEONARD, M., resigned Dec. 31, 1939.

SARASON, SAMUEL DAVIS, M., resigned Dec. 8, 1939.

SARTOR, RALPH HENRY, Assoc. M., resigned Dec. 31, 1939.

SCALES, WILLIAM EDWARD, Affiliate, resigned Dec. 31, 1939.

SCHOLTZ, WALTER, Jun., resigned Dec. 31, 1939.

SCHROEDER, THEODORE WILLIAM, Assoc. M., resigned Dec. 31, 1939.

SHOEMAKER, HARRY IVES, M., resigned Dec. 31, 1939.

STEELE, FRANCIS WARREN, Jun., resigned Dec. 31, 1939.

STIRNI, ALBERT RICHARD, Jun., resigned Dec. 31, 1939.

STUFFLER, LEE RAYMOND, Assoc. M., resigned Dec. 31, 1939.

SYREWICZ, FRANCIS JOSEPH, Jun., resigned Dec. 31, 1939.

WAHL, GEORGE RENE ROBERT, Jun., resigned Dec. 31, 1939.

WILKENS, WERNER, JR., Assoc. M., resigned Dec. 31, 1939.

WILLIAMS, GEORGE DAVID, M., resigned Dec. 31, 1939.

WINELL, VERN ELWOOD, Assoc. M., resigned Dec. 31, 1939.

WORLEY, STEWART EARL, Assoc. M., resigned Dec. 31, 1939.

WRIGHT, FREDERICK JOHN, Assoc. M., resigned Dec. 31, 1939.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

February 1, 1940 NUMBER 2

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

ANDERSSON, KINGSLEY SHERMAN, Detroit, Mich. (Age 37) (Claims RCA 5.8 RCM 8.9) Oct. 1923 to date with U.S. Army as Topographic Officer, Asst. to Dept. Engr., Corregidor, Philippine Islands, and (since Sept. 1939) Asst. to Dist. Engr.

BOSTANDJIS, HARILAOS MICHAEL, London, England. (Age 38) (Claims RCA 5.0 RCM 12.0) 1937 to date Civ. Engr., H. A. Brassert & Co., Ltd., Cons. Engrs., being Chf. Asst. to Chf. Civ. Engr.; previously Chf. Engr., Midland and South Wales Area for J. L. Eve Constr. Co., Ltd.

BRANDTZAEG, ANTON (Assoc. M.), Oslo, Norway. (Age 41) (Claims RC 14.7 D 13.4) Jan. 1937 to date Managing Director, A/S Hoyer-Ellepsen, Gen. Contrs.; previously Prof., Norwegian Inst. of Technology.

BREVIK, BERRY EDMUND (Assoc. M.), Wauwatosa, Wis. (Age 48) (Claims RCA 7.1 RCM 13.6) July 1926 to June 1931 and May 1933 to date with Portland Cement Association as Technical Engr., Field Engr., and since May 1933 also Housing Consultant and Structural Engr.; in the interim Sales Engr., Economy Block Co.

BURKEY, JOSEPH RAYMOND, Columbus, Ohio. (Age 58) (Claims RC 28.1 D 26.9) April 1939 to date Foundation Consultant, Union Metal Mfg. Co., Canton, Ohio; previously with Ohio State Highway Dept., as Div. Engr. of Bridges, Special Bridge Engr., and Chf. Engr. of Bridge and Grade Separations; Assoc. Prof. of Structural Eng., Ohio State Univ.

DICKSON, HUGH CLINT, El Paso, Tex. (Age 39) (Claims RC 6.0 D 2.8) Nov. 1939 to date Cons. Engr., on municipal, civil, and hydraulic engineering; previously Engr. for Constr. Quartermaster, Fort Bliss, Tex.; Res. Engr.-Inspector, Water Dept., El Paso; Engr. Mgr., Western Gold Mining Co.; with City of Muskogee, Okla. as City Engr.

FABER, SVEN ERIK (Assoc. M.), Hongkong, Hongkong. (Age 48) (Claims RCA 8.0 RCM 10.4) Aug. 1929 to date Cons. Civ. Engr.

GROSSMAN, EDMOND EUGENE (Assoc. M.), New York City. (Age 41) (Claims RCA 3.0 RCM 14.7) Sept. 1931 to date Engr. in charge of construction, Gen. Realty and Utilities Corporation.

GUIZADO, JOSÉ RAMON, Panama City, Panama. (Age 40) (Claims RC 10.5) 1936 to date Pres., Corporation of Engrs., S. A. Engrs., Contrs., Designers and Bldrs.; previously Prin. Member of Panama Border Comm. with Republic of Colombia.

HORNSBY, GROVER JACKSON, Denver, Colo. (Age 47) (Claims RCA 1.8 RCM 11.0) Sept. 1933 to date Engr. with U.S. Bureau of Reclamation.

HUNT, HAROLD WINFRED, Whitestone, N.Y. (Age 36) (Claims RCA 3.2 RCM 7.5) Feb. 1938 to date Constr. Engr. and Asst. Supt., Corbetta Constr. Co., New York City; previously with TVA as Senior Inspector, supervising design, designing forms, etc., for dams.

KEMP, EULAS HINSON, Savannah, Ga. (Age 35) (Claims RCA 1.6 RCM 10.8) July 1937 to date Gen. Supt., Espy Paving and Constr. Co.; previously in private practice constructing bridges, culverts, paving, sewers, water systems, and sewage-disposal plants.

LEBBY, THOMAS DOTTERER, Chattanooga, Tenn. (Age 43) (Claims RCA 1.3 RCM 20.5) Feb. 1935 to date with Constr. and Maintenance Div., TVA, as Field Supt., and (since Aug. 1936) Div. Supt.; previously member of firm Steel & Lebby, Knoxville, Tenn.

MILNER, LEROY MONROE, SR., Memphis, Tenn. (Age 49) (Claims RCA 13.3 RCM 8.9) Sept. 1928 to date Inspector, U.S. Engr. Office.

PAIGE, CLAYTON WHITNEY (Assoc. M.), Alhambra, Calif. (Age 37) (Claims RCA 5.6 RCM 7.5) March 1931 to date with City of Alhambra as Asst. Engr., Water Dept., and (since July 1933) City Engr. and Supt. of Streets.

RANDALL, GEORGE HAROLD, Harrisburg, Pa. (Age 45) (Claims RCA 4.1 RCM 14.3) Nov. 1926 to March 1927 and May 1927 to date with Ralph Modjeski, Cons. Engr., New York City as Asst. Engr., and (since June 1930) Prin. Asst. Engr., for Ralph Modjeski, also Modjeski, Masters & Case and Modjeski & Masters.

SAXE, VAN RENSSELAER POWELL (Assoc. M.), Baltimore, Md. (Age 55) (Claims RCA 4.0 RCM 27.0) 1920 to date Cons. Engr., being Engr. Adviser and Consultant to owners and architects.

SOULE, CARLTON MANSON, Baltimore, Md. (Age 55) (Claims RCA 8.1 RCM 18.7) Oct. 1938 to date Associate Engr., J. E. Greiner Co.; previously Director of Operations, Dist. No. 1 of Maryland, WPA; Cons. Engr., Soule & Zepp, Inc., Cons. Engrs.

UTTON, JOHN CLAREMONT, Minneapolis, Minn. (Age 59) (Claims RCA 20.7 RCM 14.3) Sept. 1933 to date with PWA for State of Minnesota, as Office Engr., and Traveling Engr. in charge of public buildings, sewage-disposal plants, etc.

VAYDA, EUGENE JOSEPH (Assoc. M.), New York City. (Age 47) (Claims RCA 2.4 RCM 10.0) Jan. 1938 to date Asst. Engr., City of New York, successively with Board of Transportation, and Board of Water Supply; previously Engr., Designer, etc., with various architects, engineers, and with WPA.

APPLYING FOR ASSOCIATE MEMBER

ARMSTRONG, FRANCIS WALLIS, JR. (Junior), Moorestown, N.J. (Age 32) (Claims RCA 1.3 RCM 0.0) Sept. 1938 to date Engr., Foundations, Inc.; previously with Shedwick & Willis; Asst. Supt., Timekeeper, etc., with Turner Constr. Co.

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(INDIANA)

AX, CLARENCE HERMAN (Junior), St. Louis, Mo. (Age 32) (Claims RCA 2.9 RCM 3.0) Jan. 1935 to date with Portland Cement Association as Structural Engr., and (since Aug. 1939) Field Engr.

BERRY, DAVID MAURICE (Junior), Sacramento, Calif. (Age 32) (Claims RCA 2.6 RCM 0.0) Feb. 1929 to June 1933 and Jan. 1934 to date with California Div. of Highways as Jun. Eng. Field Aid, Senior Eng. Field Aid, and (since April 1936) Jun. Bridge Engr., Bridge Dept.

BUE, CONRAD DAHL, Helena, Mont. (Age 36) (Claims RC 3.4) July 1928 to date with U.S. Geological Survey on Mokelumne River investigation, as Jun. Engr., Asst. Engr. acting as Asst. to Engr., and (since Aug. 1939) on stream-flow computations and water-supply studies.

CLARK, KENNETH ALLEN (Junior), White Plains, N.Y. (Age 32) (Claims RCA 3.5 RCM 0.0) March 1932 to date with S. A. Healy Co. (Gen. Contr. on heavy construction).

CULBREATH, MARK CARNAHAN, Kansas City, Mo. (Age 42) (Claims RCA 6.7 RCM 2.3) Aug. 1930 to date (except summer 1931) with Burns & McDonnell Eng. Co., on municipal utility design, valuation and report, including waterworks, power and sewage-treatment plants, etc.

DAVTZ, ALEXANDER BARNETT, Dorchester, Mass. (Age 36) (Claims RCA 4.6 RCM 0.0) May 1933 to date successively with Massachusetts Metropolitan Dist. Water Supply Comm. on sub-professional work and as Structural Designer; Designer and Checker for E. B. Badger & Co.; Chf. Engr., United Concrete Corporation; Oct. 1931 to date also Instructor, Lincoln Technological Inst. (Northeastern Univ. Night School).

EICHLER, JOHN ORAN FRANCIS, Syracuse, N.Y. (Age 34) (Claims RCA 2.3 RCM 0.0) Sept. 1939 to date Instructor in Civ. Eng., Syracuse Univ.; previously Engr. and Mgr., Thousand Acres, Inc., Stony Creek, N.Y.; Engr., and Asst. Supt., John McKeefrey, Inc., New York City, Bldrs. and Contrs.

ENDRESS, STEPHEN GARDNER (Junior), Fort Worth, Tex. (Age 32) (Claims RCA 4.0) March 1929 to date Office and Field Engr. with Hawley and Freese; Hawley, Freese and Nichols; Freese and Nichols, Cons. Engrs.

ENEY, WILLIAM JOSEPH, Bethlehem, Pa. (Age 34) (Claims RCA 3.6 RCM 3.3) Feb. 1936 to date with Dept. of Civ. Eng., Lehigh Univ. as Instructor, and (since Sept. 1938) Asst. Prof.; previously with Baltimore & Ohio R.R., as Inspector, Levelman, Transitman, Engr., Draftsman, and Designer.

FISHER, RALPH LASHER, Penbrook, Pa. (Age 34) (Claims RCA 1.2 RCM 0.0) Nov. 1938 to date Senior Designer, Pennsylvania Turnpike Comm.; previously Draftsman, Port of New York Authority; with U.S. Coast & Geodetic Survey on drafting and field work for aerial maps.

HANSON, ARTHUR HENRY (Junior), Salt Lake City, Utah. (Age 31) (Claims RCA 5.3 RCM 0.0) May 1937 to date with U.S. Dept. of Agriculture, AAA, as Jun. Field Officer and (since Dec. 1939) Associate Cartographic Engr.; previously Jun. Hydr. Engr., Water Resources Branch, U.S. Geological Survey, Tacoma, Wash.; with U.S. Engrs., Fort Peck, Mont., as Chf. of Party, and Shift Engr.

HART, ORVILLE HAVEN (Junior), Sacramento, Calif. (Age 31) (Claims RCA 6.7 RCM 0.0) Nov. 1927 to March 1928 and July 1928 to date Draftsman, Jun. Engr., Asst. Engr., and (since Jan. 1936) Asst. and Associate Engr., U.S. Engr. Office, Sacramento Dist.

HASSON, HERBERT HESS, Battle Creek, Mich. (Age 35) (Claims RCA 5.4 RCM 0.0) Aug. 1938 to date San. Engr., W. K. Kellogg Foundation; previously San. Engr. with Van Buren County Health Dept., and Calhoun County Health Dept.

HICKS, JAMES MOYER, Baltimore, Md. (Age 35) (Claims RCA 7.3 RCM 0.0) Nov. 1934 to date with U.S. Engr. Office as Eng. Draftsman, Jun. Engr., acting as Chf. Draftsman and Asst. to Bridge Supervisor, and (since March 1938) Asst. Engr., Flood Control Sec.

HOBBS, SAMUEL, Los Angeles, Calif. (Age 48) (Claims RCA 25.6 RCM 0.0) Jan. 1923 to date Field Engr. with Portland Cement Association.

HOLLYFIELD, JOHN BURGIN, Norris, Tenn. (Age 35) (Claims RCA 7.6 RCM 0.0) Sept. 1939 to date Asst. Structural Engr., TVA, Knoxville, Tenn.; previously Designer, Arthur G. McKee & Co., Cleveland, Ohio; Designer and Draftsman, Blaw-Knox Co., Pittsburgh, Pa.

KULIN, HARVEY JULIUS, Brookfield, Ill. (Age 28) (Claims RC 2.0) Oct. 1937 to date San. Sales Engr., American Well Works; previously Sales Engr. and Correspondent, Sewage Treatment Dept., Chicago Pump Co.; Clerk, Pump and Diesel Depts., Fairbanks, Morse & Co.

LORD, ROY STANLEY (Junior), Pasadena, Calif. (Age 32) (Claims RCA 3.5 RCM 1.8) June 1930 to date with Water Resources Branch, U.S. Geological Survey as Jun. Engr., and (since June 1936) Asst. Hydr. Engr.

LYTLE, WILLIAM JOHN (Junior), Urbana, Ill. (Age 30) (Claims RCA 2.1 RCM 6.2) Aug. 1928 to date with W. E. O'Neil Constr. Co., Chicago, Ill., as Timekeeper, Instrumentman, Asst. Engr., Asst. Field Supt., Asst. Supt., and Supt.

MCMORROW, BERNARD JAMES, Hilo, Hawaii, T. H. (Age 30) (Claims RCA 4.2 RCM 1.0) Feb. 1939 to date Administrative Officer and San. Engr., Board of Health, Island of Hawaii; previously San. Engr., Maricopa County Health Unit, Phoenix, Ariz.

MOORE, RAYMOND LEWIS, New Kensington, Pa. (Age 34) (Claims RCA 4.5 RCM 0.0) July 1929 to date Research Structural Engr., Aluminum Research Laboratories, Aluminum Company of America.

MURDAUGH, CLAUDIUS WALKE, Baltimore, Md. (Age 38) (Claims RCA 6.7 RCM 0.0) June 1929 to Jan. 1932 and May 1934 to date with Baltimore & Ohio R.R. Co. as Levelman, Chainman, Rodman, and (since Nov. 1935) Transitman.

MURPHY, GLENN (Junior), Ames, Iowa. (Age 32) (Claims RCA 4.0 RCM 1.5) Sept. 1932 to date with Iowa State Coll. successively as Instructor, Asst. Prof., Asst. Materials Engr., Eng. Experiment Station, and (since July 1938) Associate Prof., and Associate Research Prof.

NOLAND, THOMAS JEFFERSON, JR. (Junior), Denver, Colo. (Age 32) (Claims RCA 3.0 RCM 0.0) 1931 to date with U.S. Bureau of Reclamation as Jun. Engr. and Asst. Engr.

OWENS, GEORGE EDWARD, Kansas City, Mo. (Age 37) (Claims RCA 14.4 RCM 0.0) July 1932 to date Gen. Supt. of Bridge Constr., The Massman Constr. Co.; previously Res. Engr., Arkansas State Highway Dept.

REYNOLDS, GEORGE LAWRENCE (Junior), Glendale, Calif. (Age 31) (Claims RCA 1.5 RCM 0.0) March 1934 to Jan. 1936 and July 1936 to date with U.S. Forest Service, Los Angeles, Calif. as Asst. to Engr., Jun. Engr., and (since Aug. 1938) Asst. Engr.; in the interim Bricklayer, Bookkeeper, and Estimator for D. F. Reynolds, Brick Contr.

SAWYER, ALFRED WORCESTER (Junior), New York City. (Age 28) (Claims RCA 1.6 RCM 0.2) June 1935 to date Jun. Asst. Engr. with Malcolm Pirnie.

SEARLES, ARTHUR EDMUND, San Antonio, Tex. (Age 41) (Claims RC 11.7 D 11.5) Aug. 1929 to date with J. W. Beretta Engrs., Inc., as Cons. Engr., and (since June 1933) Vice-Pres.

SMYSER, MAURICE BOYER, Elkins Park, Pa. (Age 31) (Claims RCA 2.4 RCM 0.0) Jan. 1933 to July 1939 with Union Paving Co., Philadelphia, Pa., as Foreman, Engr., Supt., Estimator, and (after Nov. 1938) Engr. and Asst. Supt.

SWEAT, WESLEY ALBERT (Junior), DeLand, Fla. (Age 32) (Claims RCA 2.0 RCM 2.8) Feb. 1931 to date with State Road Dept. of Florida as Draftsman, Designer, Asst. to Location Engr., Chief Designer, and (since Jan. 1938) Location Engr.

TRIGGS, JAMES FREDERICK (Junior), Wilkinsburg, Pa. (Age 33) (Claims RCA 9.4 RCM 0.0) Aug. 1928 to Jan. 1933 Draftsman and Engr., and March 1939 to date Engr., McCully Eng. Co.; in the interim Project Engr., Dist. Office Engr., and Asst. Dist. Engr., Pennsylvania Dept. of Highways; Planetable Topographer and Chf. Engr., Pittsburgh Planning Comm.; private surveying practice.

TYRRELL, FRANK CHARLES (Junior), Denver, Colo. (Age 32) (Claims RCA 3.1 RCM 0.0) Sept. 1933 to date Asst. Engr., U.S. Bureau of Reclamation.

WOOD, FRANK BURTON, Vicksburg, Miss. (Age 36) (Claims RCA 7.6 RCM 4.3) Nov. 1927 to April 1933 and Dec. 1933 to date with Alabama State Health Dept., as Asst. State Director, Asst. San. Engr., and (since Dec. 1939) Associate Engr. (Sanitary).

APPLYING FOR JUNIOR

ASSICURATO, THOMAS, New York City. (Age 20) 1939 B.C.E., Coll. of City of N.Y.

BENSIN, FRED JULIUS, Richmond Hill, N.Y. (Age 30) (Claims RCA 0.5) Jan. 1937 to date Engr., C. W. Lauman & Co., Inc., on water-supply contracting; previously Draftsman, Aerovox Wireless Co.; Hydr. Engr. (WPA), U.S. Geological Survey; Recorder, War Dept., U.S. Engr. Dept.; Investigator with Angus D. Henderson, for New York State Water Power and Control Comm.

BRAUNSTEIN, LEONARD, Pittsburgh, Pa. (Age 24) 1937 B.S. in Civ. Eng., Carnegie Inst. Tech., Oct. to Nov. 1937 Rodman and Chainman, and July 1939 to date Jun. Engr. with U.S. Engr. Office; in the interim Draftsman and Jun. Engr., Allegheny County, Pittsburgh.

ERB, CARL LEE, JR., Ogallala, Nebr. (Age 26) Dec. 1935 to Feb. 1937 and Dec. 1937 to date with The Central Nebraska Public Power and Irrigation Dist., as Survey Party Chf., Draftsman, and Designer, Hydr. Design Dept., and (since Oct. 1938) Office Engr., Kingsley (Keystone) Dam; previously Head Chainman and Instrumentman, Chicago, Burlington & Quincy R.R.

HARDISON, CLAYTON HAINES, Montgomery, Ala. (Age 28) (Claims RCA 2.5) July 1936 to date Jun. Hydr. Engr., Water Resources Branch, U.S. Geological Survey; previously Laboratory Helper and Inspector, Soils Laboratory, U.S. Engr. Office, Eastport, Me.; Levelman and Transitman with Local Control Survey of U.S. Coast and Geodetic Survey.

HARRIS, FREDERICK ARTHUR, Vicksburg, Miss. (Age 27) Sept. 1935 to date with U.S. Waterways Experiment Station as Jun. Eng. Aide to Eng. Aide, and (since Nov. 1939) Jun. Engr.

HAYWOOD, OLIVER GARFIELD, JR., Cambridge, Mass. (Age 28) (Claims RCA 1.4) 1936 B.S. U.S. Mil. Acad.; Sept. 1938 to date graduate student, at present at Harvard Univ.

HEALY, JOHN EDWARD, Wilmington, Del. (Age 23) 1939 B.C.E., Univ. of Del.

JOERG, ERNEST MASON, Pittsburgh, Pa. (Age 29) May 1937 to date with U.S. Engr. Office as Topographic Draftsman, and (since Dec. 1938) Senior Topographic Draftsman; previously Cross-Section Draftsman, Kansas State Highway Comm.

KULHAN, EDWARD FRANK, Los Angeles, Calif. (Age 24) 1939 B.S. in C.E., Univ. of Nevada; May 1938 to Aug. 1939 with U.S. Geological Survey as Rodman, Recorder, and Asst., Topographic Div., being Party Chf.

MCLEAN, LOUIS KENNETH, Bayard, Nebr. (Age 26) 1939 B.S. in Civ. Eng., Univ. of Mo.; Oct. 1939 to date Instrumentman, Bureau of Reclamation, CCC, Pathfinder Irrigation Dist.

RHODES, FORREST LEROY, Elko, Nev. (Age 29) (Claims RCA 2.0) Aug. 1938 to date with PWA, FWA, San Francisco, as Asst. Res. Engr. Inspector; previously with Dept. of Agriculture, SCS, Bureau of Indian Affairs, Dept. of Interior, AAA, Sierra Pacific Power Co., etc.

RUSS, MYRON HAMILTON, Tulsa, Okla. (Age 22) 1939 B.S. in C.E., Univ. of N.Dak.; Nov. 1939 to date Jun. Engr., U.S. Engr. Office.

SEIF, EMANUEL, Brooklyn, N.Y. (Age 22) 1939 B.C.E., N.Y. Univ.

SHAW, HOWARD EARLE, JR., Portland, Me. (Age 26) 1937 B.S. in C.E., Univ. of Maine; 1938 M.S. in San. Eng., Harvard Univ.; Sept.-Nov. 1939 Constr. Engr., Sanders Eng. Co.; previously Jun. Engr. Inspector, PWA; Research Engr., Portland Water Dist.

WADE, GEORGE EDWIN, Reno, Nev. (Age 24) 1939 B.S. in C.E., Univ. of Nev.

WALKER, WILLIAM THOMAS, Knoxville, Tenn. (Age 23) 1939 B.S. in Civ. Eng., Univ. of Tenn.; July to Sept. 1939 Asst. Project Engr., WPA; at present graduate student.

WOLFF, JEROME BENJAMIN, Baltimore, Md. (Age 21) 1938 B.S. in C.E., Northwestern Univ.; Nov. 1939 to date Structural Eng. Draftsman, Design Dept., War Dept.; previously Jun. Engr. and Designer, Manly Equipment Co., Chicago, Ill.; Jun. Engr., PWA.

WORMALD, FRANK, Brooklyn, N.Y. (Age 24) 1939 B.C.E., Coll. of City of New York; Sept. 1939 to date Fellow in Civ. Eng., Coll. of City of New York, being Field Instructor in elementary surveying, etc.

ZWERNER, GENE ARTHUR, Washington, D.C. (Age 27) March 1935 to date with U.S. Dept. of Agriculture, Soil Conservation Service as Jun. Engr., and (since June 1937) Asst. Engr.

APPLYING FOR AFFILIATE

BOSWELL, HAROLD C., Sioux City, Iowa. (Age 42) (Claims RCA 20.8 RCM 0.0) 1920 to date with Western Asphalt Paving Corporation (Western Contr. Corporation) as Timekeeper, Asst. Supt., Constr. Supt., and (since Jan. 1927) Secy. and Treas.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 125 of the 1939 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

Construction

Civil Engineer; Assoc. M. Am. Soc. C.E.; technical graduate; licensed, New York State; 26 years experience, covering design, construction, administration, investigations, and reports in sanitary, municipal, and general engineering fields. C-635.

Design

Architectural and Structural Engineer; M. Am. Soc. C.E.; University of Pennsylvania graduate, civil engineering; 20 years varied experience with engineers and architect on steel and reinforced concrete design, detailing, and construction; 9 years in one office, responsible for both engineering and architectural work. Also experience in construction work in field. Registered engineer, Pennsylvania. Wishes position with engineer, architect, or contractor. C-642.

Structural Engineer; M. Am. Soc. C.E.; 35 years experience design and construction of all types of bridges and buildings, both steel and concrete. Special study and experience in design and construction of indeterminate structures; 20 years contract and construction executive in sale and erection of fabricated steel; open for immediate engagement any place. C-643.

Executive

Construction or Engineer-Executive; M. Am. Soc. C.E.; general manager, construction manager, chief engineer, engineering and contracting companies; 25 years unusually broad experience in design and construction of industrial plants, public utilities, foundations, waterfront work; appraisals, reports. Now engineering executive with large engineering and construction company; available promptly as executive of engineering and construction, or manufacturing, concern. C-637.

Civil Engineer; M. Am. Soc. C.E.; 41; graduate. Desires connection with highway construction organization, or a company selling general municipal or highway equipment; 14 years widely varied municipal experience. Marked energy, initiative, ability to mix with all classes and nationalities. Mason; Rotarian. Speaks Spanish. Available now. Location desired: anywhere in North or South America. C-641.

Water Works Engineer; M. Am. Soc. C.E.; registered in Pennsylvania and West Virginia; over 25 years experience in design, construction, and management of water properties. Valuation experience with utilities and public service commission. Available now—any location. C-644.

Junior

Civil and Construction Engineer; Jun. Am. Soc. C.E.; 25; single; B.S.C.E., Norwich University, 1938; specialized in structural steel and reinforced concrete design and construction; 1 year of experience in building construction—half of this time in direct supervising of work. Makes friends easily. Available immediately. Location immaterial. C-636.

Civil Engineer; Jun. Am. Soc. C.E.; 27; single; B.S.C.E., Worcester Polytechnic Institute, 1935; 4 years as resident engineer on roadside development and sidewalk construction, estimates, design, layout, inspection, costs, reports; desires civil engineering position with opportunity for advancement. Available immediately; location immaterial. C-638.

Civil Engineer; Jun. Am. Soc. C.E.; 24; married; B.S.C.E., 1936; experience—traffic survey, construction foreman and estimator, surveying, steel shop work; 3 years drafting including tanks, machine parts, maps, engraving, advertising copy, show card, etc. Payroll and sales analysis, cost accounting. Drafting equipment design, some machine design. Available immediately, any location. C-639.

Civil Engineer; Jun. Am. Soc. C.E.; 28; single; B.S.C.E., Cooper Union, 1934; M.C.E., Brooklyn Polytechnic Institute, 1938; specialized soil mechanics; 2 years inspection and survey work for tunnel and building construction; 2 years estimating and layout computations for tunnel and heavy construction; 1½ years as office engineer on tunnel and other heavy construction. C-640.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 115 of the Year Book for 1939. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

America's Treasure. By W. M. Reed; edited by C. Croneis. New York, Harcourt, Brace & Co., 1939. 395 pp., illus., 9½ × 6½ in., cloth, $3.

The story of the mineral wealth of the United States is told in simple language, with emphasis on the geological background of the deposits of metals, petroleum, and building stone. The later chapters deal with a variety of subjects—erosion, production and power statistics, inventions, athletic prowess, slum clearance, and the future of America.

Automatic Design of Continuous Frames in Steel and Reinforced Concrete. By L. E. Grinter. New York, Macmillan Co., 1939. 141 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.

The design process explained and advocated is based on the method of balancing moments, and consists of a series of successive corrections in which the crudity or refinement of the analyses approximates that of the respective preliminary designs. Much of the author's previously published material has here been reorganized, together with additional information, to enable the designer to apply automatic design methods to continuous structures.

Great Britain. Department of Scientific and Industrial Research. Building Research. Technical Paper No. 22. Studies in Reinforced Concrete. V. Moment Redistribution in Reinforced Concrete. By W. H. Glanville and F. G. Thomas. 52 pp., 40 cents. Technical Paper No. 24. Studies in Reinforced Concrete. VII. The Strength of Long Reinforced Concrete Columns in Short Period Tests to Destruction. By F. G. Thomas. 29 pp., 25 cents. Technical Paper No. 26. The Solubility of Cements. By F. M. Lea. 17 pp., 15 cents. London, His Majesty's Stationery Office, 1939, illus., diagrs., charts, tables, 10 × 6 in., paper (obtainable from British Library of Information, 50 Rockefeller Plaza, New York).

Technical Papers No. 22 and No. 24 are concerned with the effect of inelastic deformations (creep) in reinforced concrete, and describe investigations pursued along this line, listing the resulting data. No. 26 presents the results of a study of methods for testing the relative susceptibilities of various cements to loss of lime by leaching when soft waters percolate through them.

Cast Iron Pipe. By P. Longmuir. Philadelphia, J. B. Lippincott Co., 1939. 104 pp., illus., diagrs., tables, 8 × 5 in., cloth, $2.

The manufacture and properties of cast iron pipe are briefly described, with special reference to the centrifugal casting process. Pipe joints and methods of metallurgical control are also discussed. The book is a welcome addition to the scanty literature on pipe making.

Concrete Pipe in American Sewerage Practice. Bulletin No. 17, prepared and edited by M. W. Loving. Chicago, American Concrete Pipe Association, 1938. 96 pp., also supplements, illus., diagrs., charts, tables, 9 × 6 in., leather, apply.

A brief history of sanitary engineering, technical data on sewerage systems and concrete sewer-pipe, and illustrative examples of modern sewerage improvements are presented, mainly in the form of reprints from other sources. Several A.S.T.M. specifications and American Concrete Pipe Association bulletins are also included.

Foundations and Earth Pressures. By C. H. Wollaston. London, Hutchinson's Scientific & Technical Publications, 1939. 295 pp., diagrs., charts, tables, 9 × 6 in., cloth, 21s.

The opening section describes subsoil classification, soil-mechanics theory, the testing of subsoils, foundation types and methods, and shear and bond stresses. In Part II earth pressure calculations, including cohesion and distribution effects, are considered, together with retaining walls. Practical design, with calculations for specific cases, appears in Part III.

General Cartography. By E. Raisz. New York and London, McGraw-Hill Book Co., 1938. 370 pp., illus., diagrs., charts, maps, tables, 9½ × 6 in., cloth, $4.

Map making in all its phases is presented, beginning with historical information. The remainder of the first section deals with scales and projections, representation of earth features, lettering, composition, and drafting of maps. The second section discusses maps for special purposes, including graphical and statistical maps, cartograms, science maps, etc. Globes, models, field sketching, and cataloging are also considered. The work is said to be the first American text on the subject.

(A) History of the Growth of the Steam-Engine. By R. H. Thurston. Centennial edition with a supplementary chapter by W. N. Barnard. Ithaca (N. Y.), Cornell University Press, 1939. 555 pp., illus., diagrs., charts, tables, 8 × 5 in., cloth, $3.

In commemoration of the centenary of Thurston's birth, his classic treatise has been republished from the plates of the 1907 edition. A final chapter by Prof. William N. Barnard supplies a brief supplementary history of steam-power engineering from 1870 to 1939.

Land Drainage and Reclamation, 2 ed. By Q. C. Ayres and D. Scoates. New York and London, McGraw-Hill Book Co., 1939. 496 pp., illus., diagrs., charts, tables, 9½ × 6 in., cloth, $4.

The purpose of this text is to cover the problems of drainage, reclamation, and surveying that arise on the average farm and which the farmer himself can be expected to handle. After a discussion of the broad aspects of land reclamation, the text deals with land surveying, surface drainage, clearing of land, subsurface drainage, and erosion control. Problems and references accompany some chapters.

Power Economics for Engineering Students. By R. C. Gorham. Pittsburgh, Pa., Pittsburgh Printing Co., 1939. 310 pp., diagrs., charts, tables, 9½ × 6 in., cloth, $3.25.

The necessity for engineering economy is stressed in Part A, which presents fundamental concepts and factual information, with general principles which are applicable to engineering practices for best over-all economy. Part B furnishes the opportunity for the application of the preceding principles, largely through the use of examples from public utility practice. There are lists of references and many problems.

Principles of Sedimentation. By W. H. Twenhofel. New York and London, McGraw-Hill Book Co., 1939. 610 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $6.

The purpose of this book is to present a comprehensive discussion of the sources of sediments; the environmental factors that influence their production, transportation, and deposition; the various methods by which sediments are transported from source to site of deposition; the various products which result from operation of sedimentary processes; and the structures which arise as a consequence of deposition. Literature references directly follow the several topics discussed.

Photo courtesy Electro-Motive Corp.

THE IRON HORSE IS ON A DIET

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This Diesel-powered streamliner with a three or four car train does the same amount of work and consumes only 7 cents worth of fuel and upkeep per mile—a far cheaper diet. The streamliner has not only cut operating costs but it has sent traffic zooming up, greatly improving the complexion of railroad business.

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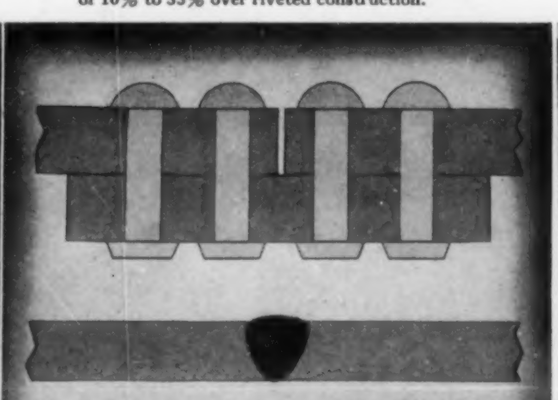
AUTOMATIC. The Lincoln Electronic Tornado produces welds of shielded arc quality for high-speed, low-cost manufacture and construction work. Here, the Tractor Type Tornado fabricates an oil storage tank. Photo courtesy Chicago Bridge & Iron Co.

***FOR EXAMPLE.** Top joint is riveted. Bottom one is "*Shield-Arc*" welded. It is stronger than the parent metal. Elimination of connecting members and ability to use lighter material in welded structures accounts for savings in weight of 10% to 35% over riveted construction.

A STRONGER BRIDGE. Stringers are reinforced by welding on I-beams with webs cut as shown. Old wooden plank flooring is replaced with welded steel grid type flooring and concrete. Courtesy J. K. Welding Co., New York.



CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Publications (Except Those of the American Society of Civil Engineers) in This Country and in Foreign Lands

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Pontoon, Turkey. Rigid Frame Superstructure on Pontoon Bridge, E. R. Wiseman. *Eng. News-Rec.*, vol. 123, no. 13, Sept. 28, 1939, p. 52. Construction of steel pontoon highway bridge across Golden Horn at Istanbul, Turkey, 1,500 ft long and 82 ft wide.

Steel Arch, Reconstruction. Reconstruction of Calder Bridge, L. N. E. R. *Ry. Gas.*, vol. 71, no. 9, Sept. 1, 1939, pp. 321–322. Notes on construction of old Calder Bridge, near Wakefield, built in 1865, consisting of cast iron arch reinforced with certain wrought iron members; method of removal of superstructure and replacement with segmental arch span on 69-deg skew; in each of three pairs of arched ribs there is lead of 1 ft $7^{21}/_{32}$ in. between ribs forming pair, and lead between adjacent pairs is 2 ft $6^{3}/_{8}$ in.; bridge will carry 20 units, B.S.I., loading for railway bridge.

Steel, Germany. Die Entwicklung der Stahlbruecken bei den Reichsautobahnem, Burger. *Bautechnik*, vol. 17, no. 13, Mar. 28, 1939, pp. 169–180. Review of developments of design and construction practices for long steel truss and plate girder bridges along superhighway system of Germany.

Steel, Germany. Zwei Zweigelenkrahmenbruecken ueber den Elster-Saale-Kanal, G. Gerstenberger. *Bautechnik*, vol. 17, no. 15, Apr. 7, 1939, pp. 213–215. Design and construction of two-hinged steel frame bridge having span of 45 m over Elster-Saale Canal, Germany.

Suspension, Design. Calcul des ponts suspendus, Pigeaud. *Annales des Ponts et Chaussées*, vol. 109, nos. 3 and 4, Mar. 1939, pp. 305–350, and Apr., pp. 421–470. General theory of design of suspension bridges; methods of equalization of pressures in case of single and triple spans; effect of wind stresses; analysis of structures with elastic end supports, having no pressure equalizing members; structures with continuous stiffening girders.

Wooden, Washington. Timber Truss Record Established on Columbia River Bridge at Cathlamet. *Western Construction News*, vol. 14, no. 7, July 1939, pp. 223–226. Construction of wooden portion of new long highway bridge over Columbia River at Cathlamet, Washington, consisting of nine 80-ft spans, including use of 24,000 ring-connectors and 800,000 fbm of Wolmanized lumber; design details of timber trusses; foundations for timber truss spans; floor system.

Wooden, Yugoslavia. Eine Weitgespannte Holzbogenbruecke in Jugoslavien, S. Dimnik. *Bauingenieur*, vol. 20, no. 25/26, June 30, 1939, pp. 339–342. Design and construction of timber arch bridge, with span of 85 m and rise of 21 m, over Kokra River, at Krani, Yugoslavia; testing of bridge.

CITY AND REGIONAL PLANNING

Town and Country. Town and Country Planning, H. J. Manzoni. *Surveyor*, vol. 96, no. 2479, July 28, 1939, pp. 99–102. Planning schemes for built-up areas; national planning; control of urban expansion; spur development; recent factors affecting town and country planning; restriction of ribbon development; air raid precautions. Before Instn. Civ. Engrs.

CONCRETE

Aggregates. Concrete Aggregates for World's Longest Multiple Arch Dam. *Rock Products*, vol. 42, no. 7, July 1939, pp. 26–27. In northeastern Oklahoma, Massman Construction Company obtains coarse aggregate from new quarry and sand by dredge from Arkansas River; storage facilities are provided for five sizes.

Aggregates. Unique Rock Crushing at Hiwassee Dam. *Eng. News-Rec.*, vol. 123, no. 13, Sept. 28, 1939, pp. 53–56. Methods of converting highly silicious rock into concrete aggregates by means of elaborate dust collecting system, without health hazard; flow sheet of aggregate production operations; equipment arrangement in crusher building; flow sheet of rock movement through crusher plant to produce sand and four sizes of stone aggregate in controlled proportions; sizing screens.

Construction. Architectural Concrete, W. D. M. Allan. *Water Works & Sewerage*, vol. 86, no. 11, Nov. 1939, pp. 427–430. Adaptation of architectural concrete to construction of buildings, housing, water works, and sewage disposal plants; formwork; control of concrete; joints; curing and stripping; architectural treatment.

Construction. Job Problems and Practice. *Am. Concrete Inst.—J.*, vol. 11, no. 2, Nov. 1939, pp. 213–220. Brief discussions of following problems: Handling materials and products in small block plants; floors in light-occupancy buildings; effect of animal and vegetable oils on concrete; effect of high temperature on concrete; effect of long-time mixing; bond strength of triangular reinforcing bars.

Design. Bending and Compression (or Tension) in Reinforced Concrete, G. Supino. *Concrete & Constr. Eng.*, vol. 34, no. 9, Sept. 1939, pp. 487–490. Theoretical mathematical analysis of principal stresses in reinforced concrete sections.

Floors. Corridor Beam Floors, C. A. Wilson. *Am. Concrete Inst.—J.*, vol. 11, no. 2, Nov. 1939, pp. 165–168. Design and construction of shallow-floor system for new men's dormitories at University of Wisconsin, permitting reduction in story heights; cost of form work and simplification of partitions.

Mixing. Proportioning Concrete for Strength and Workability, A. R. Collins. *Concrete & Constr. Eng.*, vol. 34, no. 10, Oct. 1939, pp. 557–568. Tables and charts for design of concrete mixes to meet certain requirements as to strength and workability; relation between crushing strength and water cement ratio for fully compacted concrete; aggregate grading curves; practical examples.

Roads and Streets. Well-Conducted Concrete Job in Illinois. *Roads & Streets*, vol. 82, no. 9, Sept. 1939, pp. 60, 62, and 64. Equipment and methods used in construction of stretch of 7.06 miles of concrete slab on Illinois Route 89B; subgrade finishing; material handling and hauling.

Siphons. Concrete Corners in Tension, D. B. Gumensky. *Eng. News-Rec.*, vol. 123, no. 13, Sept. 28, 1939, p. 57. Report on laboratory tests for design of proper anchorage for steel reinforcement subjected to tension and bending stresses, in corners of rectangular siphons of Colorado River Aqueduct, where sections made up of three square barrels were used; results of tension tests on five types of corner reinforcement.

DAMS

Concrete Arch Wyoming. Construction of Seminoe Dam and Power Plant, Kendrick Project, Wyoming, J. H. Warner. *Reclamation Era*, vol. 29, no. 10, Oct. 1939, pp. 269–273 and 278. Design and construction of recently completed Seminoe concrete arch dam, about 280 ft maximum height, on North Platte River, Wyoming; excavation of dam and power plant; concrete for dam and power plant; mining and backfilling of seams under dam.

Concrete Gravity, Tennessee. Technical Review of Pickwick Landing Project. *Tenn. Valley Authority—Tech. Monograph, No. 40*, Mar. 1939, 40 pp., figs, diagrs., maps. \$1. History of development of Pickwick Landing Dam project of Tennessee Valley Authority, including details of design and construction of Pickwick Landing concrete gravity dam having maximum height of 113 ft and length of 7,715 ft, also of navigation lock, 215 ft long, and hydroelectric power plant with ultimate capacity of 288,000 hp.

Earth, Seepage. Grouting to Prevent Leakage Around Earth Dam, J. F. Meisner. *Pub. Works*, vol. 70, no. 7, July 1939, pp. 12–14, 36, and 38. Description of procedures developed for grouting with mixture of 1 part cement, 12 parts clay, and 1 part aquagel to stop leakage of over 1,000 gal per min through Marion County earth-fill dam, Kansas, having maximum height of about 55 ft, length 1,200 ft.

Earth, Utah. Deer Creek Dam—Foundation Finished Ready for Main Earthfill in 1940. *Western Construction News*, vol. 14, no. 11, Nov. 1939, pp. 379–382. Progress report on initial stage of construction of earth and rock fill dam on Provo River Project in Utah, having maximum height of 155 ft, crest length of 1,300 ft; diversion and outlet works; foundation and cutoff; major units of construction equipment.

Earth, Utah. Deer Creek Dam, Provo River Project, Utah, C. H. Carter. *Reclamation Era*, vol. 29, no. 8, Aug. 1939, pp. 210–213. Design and construction of Deer Creek earth-fill dam on Provo River, Utah, having length of 1,300 ft and maximum height above stream bed of 155 ft, 240 ft above bedrock foundation; features of outlet work, spillway, and relocated railroad.

Foundations. Engineering Geology of Dams, F. A. Nickell. *Reclamation Era*, vol. 29, no. 8, Aug. 1939, pp. 197–200. Outline of modern methods and scope of geological investigations of dam sites; with special reference to practice of U.S. Bureau of Reclamation. Bibliography.

FLOW OF FLUIDS

Porous Materials. Flow of Liquids Through Beds of Granular Solids, W. H. Ward. *Engineering*, vol. 148, no. 3849, Oct. 20, 1939, pp. 435–438. Discussion of seepage of water through earth dam or similar structure; differential equation for flow of fluids through homogeneous porous media; general resistance equations. Before Sec. G of Brit. Assn.

FOUNDATIONS

Earth Pressure. Beitrag zur Berechnung der Erddruckverteilung, H. Homberg. *Bautechnik*, vol. 17, no. 34, Aug. 11, 1939, pp. 474–476. Theoretical mathematical discussion of method of completing distribution of earth pressure, taking into account results of recent research.

Geophysics. Seismic Method of Exploration Applied to Construction Projects, E. R. Shepard. *Military Engr.*, vol. 31, no. 179, Sept.–Oct. 1939, pp. 370–377. Theory of seismic exploration; determination of velocity in rock and slope of interface; relation of shooting distance to depth of exploration; speed of propagation of seismic waves in different subsurface materials; application of seismography to variety of formations.

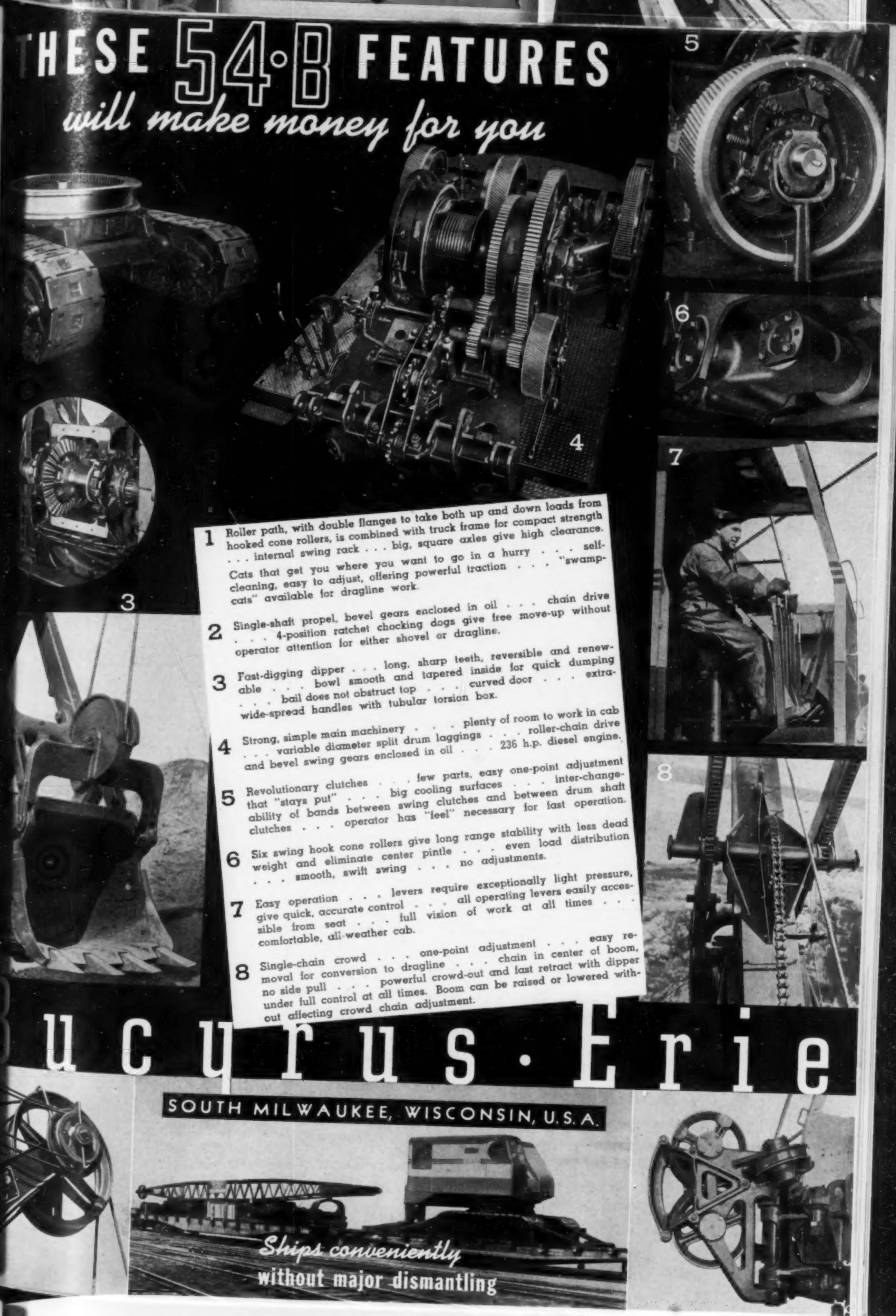
Piles, Bearing Power. La force portante des pieux, J. L. Kerisel. *Annales des Ponts et Chaussées*, vol. 109, no. 5, May 1939, pp. 579–633. Presentation of static formula of bearing power of piles, based on recent theoretical studies; report on laboratory experiments for verification of theoretical formulas.

Reconstruction. Precast Cylinders Support New Wharf. *Can. Engr.*, vol. 77, no. 5, Aug. 1, 1939, pp. 2–4. Unusual construction of caissons and timber piles used in rebuilding Saint John, New Brunswick, harbor facilities in 28-ft tide without construction of cofferdams.

HYDROELECTRIC POWER PLANTS

Colorado. Green Mountain Dam and Power Plant, S. F. Crecelius. *Reclamation Era*, vol. 29, no. 10, Oct. 1939, pp. 253–255 and 277–278. Description of hydroelectric power development in Blue River in Colorado, now in course of construction, including Green Mountain earth and rock-fill dam, over 270 ft maximum height; spillway with capacity of 25,000 cu ft per sec; diversion tunnel and outlet works; powerhouse; power line.

Hydraulic Gates. How to Select and Specify Sluice Gates, H. L. Baker. *Pub. Works*, vol. 70, no. 8, Aug. 1939, pp. 21–23. Description of various types of sluice gates and uses to which each is best adapted; non-rising stem versus rising stem; shape of opening; working pressure; frames; appurtenances for sluice gates; wedges.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2 Single-shaft propel, bevel gears enclosed in oil . . . chain drive . . . 4-position ratchet chocking dogs give free move-up without operator attention for either shovel or dragline.
3 Fast-digging dipper . . . long, sharp teeth, reversible and renewable . . . bowl smooth and tapered inside for quick dumping . . . bail does not obstruct top . . . curved door . . . extra-wide-spread handles with tubular torsion box.
4 Strong, simple main machinery . . . plenty of room to work in cab . . . variable diameter split drum laggings . . . roller-chain drive and bevel swing gears enclosed in oil . . . 236 h.p. diesel engine.
5 Revolutionary clutches . . . few parts, easy one-point adjustment that "stays put" . . . big cooling surfaces . . . inter-changeability of bands between swing clutches and between drum shaft clutches . . . operator has "feel" necessary for fast operation.
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7 Easy operation . . . levers require exceptionally light pressure, give quick, accurate control . . . all operating levers easily accessible from seat . . . full vision of work at all times . . . comfortable, all-weather cab.
8 Single-chain crowd . . . one-point adjustment . . . easy removal for conversion to dragline . . . chain in center of boom, no side pull . . . powerful crowd-out and fast retract with dipper under full control at all times. Boom can be raised or lowered without affecting crowd chain adjustment.
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ITALY. La centrale di Ponte Gardena, G. Castellani. *Elettrotecnica*, vol. 26, no. 17, Sept. 10, 1939, pp. 578–597. Design, construction, and equipment of Ponte Gardena hydroelectric power plant on Isarco River in northern Italy, with capacity of 75,000 hp; structural features of movable dam about 4 m high, desilting installation, and power canal; details of hydraulic and electric equipment.

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RAIN AND RAINFALL. Distribution of Rainfall Within Limited Area, W. H. Elgar. *Surveyor*, vol. 96, no. 2479, July 28, 1939, pp. 93–96. Theoretical study of effect of rainfall on flow in sewerage and drainage systems; types of rainfall; relation between distance and area covered by rain storms; variations in total fall; shape of storms; variation of intensity in relation to duration. Before Instn. Mun. & County Engrs.

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RUNOFF. Accuracy of Runoff Calculations, L. B. Escritt. *Surveyor*, vol. 96, nos. 2480 and 2481, Aug. 4, 1939, pp. 119–121, and Aug. 11, p. 170. Theoretical discussion of equations for intensity of rainfall and total rainfall; direct calculation diagrams; limitation of areas covered by storms; use of flow recorders; effect of surcharge; effects of storage.

RUNOFF. Grundsaetzliches ueber den Abflussbeiwert, F. Reinhold. *Gesundheits-Ingenieur*, vol. 62, no. 21, May 27, 1939, pp. 294–299. Theoretical mathematical analysis of factors affecting intensities of runoff, taking into account experimental study by author; comparison of American and European runoff formulas.

UNDERGROUND, MASSACHUSETTS. Ground Water in Pre-Glacial Buried Valleys of Massachusetts, I. B. Crosby. *New England Water Works Assn.—J.*, vol. 53, no. 3, Sept. 1939, pp. 372–383. Geological and hydrological study of underground water supply of Massachusetts; importance of buried valleys in location of ground water; deposits of buried valleys; use of geophysical prospecting.

UNDERGROUND WATER, UNITED STATES. Ground Water in United States, O. E. Meinzer. *U.S. Geol. Survey—Water-Supply Paper 836-D*, 1939, 232 pp., 15 cents. Summary of ground-water conditions and resources; utilization of water from wells and springs; methods of scientific investigation and literature relating to subject. Bibliography.

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INLAND WATERWAYS

SILT, MISSISSIPPI RIVER. Study of Materials in Suspension, Mississippi River. *U.S. Waterways Experiment Station—Tech. Memo. No. 122-1*, Feb. 1, 1939, 27 pp., supp. plates. Detailed report on observations and measurements for determination of quantity and characteristics of materials transported in suspension in Mississippi River at stages covering seasonal hydrographic range of river; determination of velocities and temperatures of river discharges.

SILT, MISSISSIPPI RIVER. Study of Materials in Transport Passes of Mississippi River. *U.S. Engrs. Office, First New Orleans District & U.S. Waterways Experiment Station—Tech. Memo. No. 158-1*, Sept. 1, 1939, 32 pp., supp. plates. Detailed report on observations and measurements for determining quantities and characteristics of silt load delta of Mississippi River; chemical analysis of silt for determination of its agricultural value.

IRRIGATION

CANALS, CALIFORNIA. Asphaltic Concrete Lining—Central Valley Project, California. *Reclamation Era*, vol. 29, no. 10, Oct. 1939, pp. 266–267. Methods and equipment used in construction of asphaltic concrete lining for Contra Coastal Canal of Central Valley Project, California, 46 miles long, with capacity of 350 cu ft per sec.

CANALS, CALIFORNIA. Rock Cuts on All-American Canal, L. E. Cramer. *Reclamation Era*, vol. 29, no. 10, Oct. 1939, pp. 282–283. Construction of several rock cuts on route of All-American Canal in southern California, involving total rock excavation of 1,303,600 cu yd to maximum depth of 100 ft.

CANALS, EROSION. Planting Willows Along Ditches to Prevent Erosion. *Reclamation Era*, vol. 29, no. 8, Aug. 1939, pp. 221–222. Discussion of varieties of willows and methods of planting them on banks of unlined irrigation canals to prevent erosion.

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WATER-APPLICATION EFFICIENCIES. Water Application Efficiencies in Irrigation and Soil Conservation, O. W. Israelsen. *Agric. Eng.*, vol. 20, no. 11, Nov. 1939, pp. 423–425. Classification of irrigated lands with respect to relative elevation; results of measurements of water applied annually to different soils; measurements of moisture and moisture distribution before and after irrigation of highland soils, lowland soils and soils of medium elevation; sources and disposal of water in soils; difficulties of measuring water stored in soil.

LAND RECLAMATION AND DRAINAGE

EROSION, CONTROL. Controlling Erosion with Creosoted-Timber Ditch Checks. *Better Roads*, vol. 9, no. 11, Nov. 1939, pp. 29–30. Design of two forms of treated timber ditch checks for roadside drainage.

MOSQUITO CONTROL, DELAWARE. *Report of Mosquito Control Work, State of Delaware*, Jan. 1 to Dec. 31, 1938. Lewes, Delaware, 85 pp., tables, diagrs., figs. Mimeographed annual report on Delaware mosquito control campaign for period Jan. 1, to Dec. 31, 1938, containing notes on mosquito control against wild life, marsh markers, mosquito-borne diseases, biological control on tidal marshes, equipment repairs, and operating costs; colored light traps; mosquito-control investment; recommendations; trap records.

SUB-SOIL WATER. Drainage of Sub-Soil Water Through Bores to Limestone Beds, A. L. Tisdall. *Commonwealth Engr.*, vol. 27, no. 2, Sept. 1, 1939, pp. 59–61. Description of novel method for removal of sub-soil water in irrigated areas by means of shaft and bore drilled down to Tertiary limestone strata; water draining into shaft passes down bore and is absorbed in limestone.

MATERIALS TESTING

CONCRETE. Laboratory Tests of Concretes and Mortars Exposed to Weak Acids, D. G. Miller, P. W. Manson, and C. F. Rogers. *Agric. Eng.* vol. 20, no. 11, Nov. 1939, pp. 427–430. Report on University of Minnesota laboratory studies of durability of portland cement mortars and concretes exposed in farm silos to corrosive action of silage; method and equipment are adapted to study of corrosive action of soluble materials on products of various types. Before Am. Soc. Agric. Engrs.

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ROAD MATERIALS, BITUMINOUS. Wyoming Laboratory Test for Stability of Oil Mix, M. C. Warner. *Western Construction News*, vol. 14, no. 11, Nov. 1939, pp. 364–365. Outline of Wyoming State Highway Department tests for determining proper amount of bituminous material to be added to aggregates for highway surface; percentage of bitumen determined by punching test on compacted sample.

MUNICIPAL ENGINEERING

TRANSPORTATION, CHICAGO, ILL. Superhighways and Subways for Chicago. *Eng. News-Rec.*, vol. 123, no. 21, Nov. 23, 1939, pp. 56–58. Brief abstracts on two recent comprehensive reports on Chicago transportation—one relating to superhighways and the other to subways; both plans are dovetailed into existing facilities within city limits and outside; plans and construction programs; cost estimates.

PORTS AND MARITIME STRUCTURES

BREAKWATERS, PORTUGAL. Extension of North Mole at Leixoes Harbour, Portugal, D. Abecasis. *Dock & Harbour Authority*, vol. 19, no. 225, July 1939, pp. 249–253, supp. plate. Design and construction of 1,000 m of rubble-mound breakwater, topped with concrete block weighing up to 90 tons, in port of Leixoes, Portugal; maximum depth to foundation 18 m; tests of protective effect of breakwaters; cost estimates.

ROADS AND STREETS

AFRICA. L'Autocamionale Assab-Addis Abeba, G. Pini. *Annali dei Lavori Pubblici*, vol. 77, no. 9, Sept. 1939, pp. 909–972. Design and construction of recently completed automobile highway, 861 km long, leading from Assab on Red Sea to Addis Abeba capital of Abyssinia; project includes many bridges and several tunnels up to 586 m in length.

COLORADO. Colorado Completes America's Highest Highway—Up Mount Evans. *Roads & Streets*, vol. 82, no. 11, Nov. 1939, pp. 37–39. Construction of 14 miles of highway, 9 miles of it oil surfaced, leading to top of Mount Evans, Colo.; elevation of 14,259 ft; methods of snow clearance; oil-surfacing.

CURVES. Vertical Curves, E. W. W. Richards. *Roads & Road Construction*, vol. 17, nos. 198, 200, and 201, June 1939, pp. 178–182; Aug., pp. 246–251; and Sept., pp. 279–281. Visibility on summit curves; vertical curve diagram; numerical examples; graphical methods of solution; length of vertical curves; braking distances; selection of appropriate rate of change of curvature; flat grade intersections; length and type of sag curves.

EMBANKMENTS, DESIGN. Design of Fill Supported by Clay Underlaid by Rock, L. A. Palmer. *Pub. Roads*, vol. 20, no. 8, Oct. 1939, pp. 157–162. Application of soil mechanics in solving highway-fill problem; analytical methods based on assumption of conditions of plane strain to problem of determining supporting power of clay stratum under symmetrical earth fill when clay stratum is underlaid by rock; stresses in clay computed from theory of elasticity; Hencky's method of plastic equilibrium applied to design of earth fills; numerical examples.

EXCAVATING MACHINERY, UNITED STATES. Greater Output at Lower Costs, etc., F. A. Nikrik. *Eng. & Contract Rec.*, vol. 52, no. 30, July 26, 1939, pp. 25–88. Abstract of paper before National Paving Conference reviewing developments of excavating and earth-moving machinery in United States during past 20 years; efficiency of modern equipment; prospects for near future.

HIGHWAY LIGHTING. Measurements Carried Out on Road Lighting Systems Already Installed, P. J. Bouma. *Philips Tech. Rev.*, vol. 4, no. 10, Oct. 1939, pp. 292–301. Measurements described (horizontal and vertical intensity of illumination, distribution of brightness, reflection coefficients, visibility); number of conclusions are drawn, on basis of all material collected; items chosen from experimental material for purpose of illustrating peculiarities of vision on artificially lighted roads.

HIGHWAY SYSTEMS, MASSACHUSETTS. Highways of Boston Metropolitan District, Their Origin and Evolution, O. D. Fellows. *Boston Soc. Civ. Engrs.—J.*, vol. 26, no. 4, Oct. 1939, pp. 267–277. Development of highway system of Boston Metropolitan District since seventeenth century; graphic statistics; population and automobile registration.

INTERSECTIONS. Paving Areas at Intersections, V. M. Wann. *Eng. News-Rec.*, vol. 123, no. 21, Nov. 23, 1939, p. 71. Construction of numerical tables for computation of pavement area of skew intersection of two highways.

MAINTENANCE AND REPAIR. How to Maintain Highways and Streets. *Pub. Works*, vol. 70, nos. 7 and 8, July 1939, pp. 32–34, and Aug., pp. 36–39. Maintenance of brick pavements; base failures; filling of cracks; relaying brick; removing excess filler; patching with brick; maintenance of stabilized soil road surfaces; maintaining moisture bond; bituminous stabilization.

MAINTENANCE AND REPAIR. Resurfacing with Natural Sandstone Rock Asphalt, N. F. Schafer. *Roads & Streets*, vol. 82, no. 9, Sept. 1939, pp. 53, 56, and 58. Outline of road-surfacing practice and experience in Indiana; drag type bituminous surface treatment; finishing machines; luting edges of freshly laid surface.

MAINTENANCE AND REPAIR. Road Maintenance Plans and Practice on Los Angeles County System. *Western Construction News*, vol. 14, no. 7, July 1939, pp. 227–229. Review of organization and field procedure required for upkeep of 4,000 miles of highway serving county with area of 3,952 sq miles and population of 2,300,000; planning for stage construction; patching.

MATERIALS, BITUMINOUS. Bitumen-Rubber Mixtures in Road Construction, G. W. Eckert. *India Rubber World*, vol. 100, no. 4, July 1, 1939, pp. 37–39 and 47. Purpose of article is to summarize published information on bitumen and rubber mixtures containing less rubber than bitumen, which have been studied for their value in road construction; subject matter classified according to five phases of logical consideration: methods of preparation, physical properties, addition agents, preparation of bitumen rubber aggregate system, and application to road construction. Bibliography.

RAILROAD CROSSINGS. This Grade Separation Involved Difficult Traffic Problem. *Ry. Age*, vol. 107, no. 21, Nov. 18, 1939, pp. 784–788. Article describes Central Railway of New Jersey's $5,000,000 project at Elizabethport, N.J.; project required elevating of two lines and four wyes.

RAILROAD CROSSINGS, ELIMINATION. This Track Depression Imposed Severe Drainage Problem. *Ry. Age*, vol. 107, no. 24, Dec. 9, 1939, pp. 882–887. Excavation, drainage, and subsequent construction problems encountered on grade separation project extending about 2 miles on Southern Railroad through High Point, N.C.

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SOIL CEMENT. Cost of Soil Cement Road Construction in Texas. *Concrete*, vol. 47, no. 9, Sept. 1939, pp. 5 and 27. Results of experiments made with local materials in Texas pursuant to construction of 47 miles of all-weather road through Kennedy County. From Information Exchange of Texas Highway Department, June 15, 1939.

STABILIZATION. Road Stabilization, R. W. Crum. *Better Roads*, vol. 9, no. 10, Oct. 1939, pp. 19–21. Simple popular statement of basic theory of soil stabilization for highway construction.

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STABILIZATION. Sub-base and Foundations for Bituminous Surfaces, J. O. Martineau. *Eng. & Contract Rec.*, vol. 52, nos. 27 and 28, July 5, 1939, pp. 11–14, and July 12, pp. 15 and 16. Analysis of causes of pavement failures attributable to subgrade soil reactions; advantages of stabilization of road bases; surface drainage; subsurface drainage; frost heaving; sliding of side slopes of cuts and fills; stabilized bases.

SUBSOILS. Subgrade and Base Course Design, N. W. McLeod. *Can. Engr.*, vol. 76, nos. 24, 25, and 26, June 13, 1939, pp. 4–10; June 20, pp. 9–12; and June 27, pp. 4–10. Application of recent findings in soil mechanics to design of subgrade and base course on low-cost roads; general theory of design for establishing base course thickness; degree of subgrade compaction; sample calculations; safety factors in base course design; improvement of subgrade; principles of drainage; soil stabilization for base courses.

TESTING. Measurement of Road Surface Roughness, C. Grossjohann. *Surveyor*, vol. 96, no. 2477, July 14, 1939, pp. 45–46. Indirect method for determining degree of road roughness; definition of surface structure of road surfaces; methods and apparatus for direct measuring of degree of roughness. Before Int. Road Tar Conference.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE. Activated Sludge Oxidations, C. N. Sawyer and G. A. Rohlich. *Sewage Works J.*, vol. 11, no. 6, Nov 1939, pp. 946–964. Influence of temperature upon rate of oxygen utilization by activated sludges; relative rates of oxygen utilization by various activated sludge sewage mixtures; effect of temperature on base rate of oxidation of sludge; nitrate formation by various activated sludges. Bibliography.

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SCREENINGS. Fine Screening of Sewage, J. A. Muldoon. *Sewage Works J.*, vol. 11, no. 6, Nov. 1939, pp. 1054–1066. Review of modern American practice of fine screening of sewage for removing part of suspended solids; types of equipment—their operation and maintenance.

SEWAGE TANKS. Die Temperatur in Schlammfaulraeumen, K. Imhoff. *Gesundheits-Ingenieur*, vol. 62, no. 22, June 3, 1939, pp. 310–311. Study of temperature in sewage digestion tanks, with special reference to rate of gas production in large and in small tanks.

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SLUDGE. Sludge Disposal at Minneapolis-Saint Paul Plant, G. J. Schroepfer. *Sewage Works J.*, vol. 11, no. 6, Nov. 1939, pp. 971–987. Operation of sludge disposal facilities at Minneapolis-St. Paul plant in year ending August 31, 1939; description of sludge disposal facilities; air and gas-flow diagram; vacuum filtration; incinerators.

SLUDGE. Sludge Drying on Beds. *Mun. Sanitation*, vol. 10, no. 11, Nov. 1939, pp. 561–562. Practical discussion of covered and uncovered sludge drying beds, rate of sludge drying, depth of wet sludge application, sludge cake removal, odor from sludge beds, disposal of sludge bed liquor.

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BEAMS, CONCRETE. Construction Design Chart—XLVII, J. R. Griffith. *Western Construction News*, vol. 14, no. 11, Nov. 1939, p. 386. Construction of alignment chart for computing vertical stirrup spacing in reinforced concrete beams; numerical examples.

DESIGN. Determination of Cross-Sectional Areas of Structural Members, J. A. Miller. *U.S. Bur. Standards—J. Research*, vol. 23, no. 5, Nov. 1939 (RP1258), pp. 621–636, 3 supp. plates. Methods of determining cross-sectional areas; procedure for applying volumetric method to members of variable cross section; time required; accuracy.

PHOTOELASTICITY. Photoelastic Analysis of Stress Distribution in Pin and Plate Joint, A. G. Solakian. *Product Eng.*, vol. 10, no. 12, Dec. 1939, pp. 548–551. Investigation of stresses by means of photoelastic methods.

PHOTOELASTICITY. Progress in Photoelasticity, R. Weller. *Wash. State College—Eng. Experiment Station—Bul. No. 60*, vol. 22, no. 6, Nov. 1939, pp 14–17. Review of development; in addition to conventional type of photoelastic study, program of research is being set up at Washington State College for furthering work in three-dimensional procedure; new type of polariscope under construction.

PLATES, BUCKLING. Stability of Rectangular Plates with Longitudinal or Transverse Stiffeners Under Uniform Compression, R. Barbre. *Nat. Advisory Committee Aeronautics—Tech. Memo. No. 904*, Aug. 1939, 52 pp., 4 supp. plates. Complete buckling conditions of stiffened plates are developed for uniform compression; plates with one or two longitudinal or transverse stiffeners at any point are discussed with reference to buckling conditions and evaluated for different cases. From *Ingenieur-Archiv.*, Nov. 2, 1937.

TUNNELS

ARIZONA. Tunnel Construction, Gravity Main Canal, E. A. Blout. *Reclamation Era*, vol. 29, no. 8, Aug. 1939, pp. 189–191 and 193. Construction of two concrete-lined water tunnels of Gila reclamation project in Arizona, having horseshoe section 20 ft in diameter and respective engths of 1,740 and 425 ft.

VEHICULAR, NETHERLANDS. Meuse Tunnel at Rotterdam. *Engineer*, vol. 168, no. 4369, Oct. 6, 1939, pp. 348–350. Illustrated description of tunnel under construction, which provides four tracks for motor traffic and additional tracks for bicyclists and pedestrians; it is not being driven under river by usual shield method, but separate sections are being constructed ashore, floated out, and sunk through water into dredged channel prepared to receive them.

VENTILATION. Die Gruendung der Lueftungsgebaeude des Maastunnels in Rotterdam, E. Schnitter. *Schweizerische Bauzeitung*, vol. 113, no. 12, Mar. 25, 1939, pp. 143–147. Design and construction of foundations for ventilating plant of Meuse River subaqueous vehicular tunnel at Rotterdam, Netherlands, having total length of 1,070 m.

WATER PIPE LINES

DISTRIBUTION SYSTEMS, DESIGN. Ueberlagerung der Kennlinien von Pumpen und Rohrleitungen, H. Goetting. *Gas u. Wasserfach*, vol 82, no. 20, May 20, 1939, pp. 381–385. Principles of comprehensive design of water distribution systems, including pipe networks, pumping stations, and distribution reservoirs; superposition method for checking of existing or projected water distribution systems. Bibliography.

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WATER RESOURCES

CANADA. Industrial Waters in Canada. Interim Report No. 4, H. A. Leverin. *Canada Dept. Mines & Resources—Bur. Mines—Memo Series No. 72*, Sept. 1939, 37 pp. Quality of surface waters and public water supplies in western Canada, including British Columbia; survey of Ontario arteries and lakes of Great Lakes watershed from Cornwall on St. Lawrence to Port Arthur on Lake Superior, to ascertain seasonal and periodical variations in their composition, as well as changes in quality of public water supplies.

UNDERGROUND, CALIFORNIA. Geology and Ground-Water Hydrology of Mokelumne Area, California, A. M. Piper, H. S. Gale, H. E. Thomas, and T. W. Robinson. *U.S. Geol. Survey—Water-Supply Paper 780*, 1939, 230 pp., supp. map. $2.25. Study of geology and ground-water hydrology of Mokelumne area in California; geomorphology and stratigraphy; general data from wells; specific yield and specific retention of water-bearing materials; fluctuations of ground-water level; regional water table; perched water tables.

WATER TREATMENT

BACTERIOLOGY. Bacteria of Lakes and Impounded Waters, C. B. Taylor. *Water & Water Eng.*, vol. 41, no. 514, Sept. 1939, pp. 475–478. Brief review of water bacteriology and results of recent studies of number and distribution of bacteria in British lake; fluctuations in bacterial numbers compared with changes in chemical content, numbers of algae in water, temperature conditions, etc.; rainfall-bacteria relationship. Before Brit. Water-Works Assn.

CHLORINATION. Superchlorination as Practiced in North America, H. A. Faver. *Water Works & Sewerage*, vol. 86, no. 9, Sept. 1939, pp. 337–345. Historical review of development of superchlorination; action of chlorine in destroying tastes and odors; methods of dechlorination; operating data; super- and dechlorination for temporary conditions; superchlorination without dechlorination; industrial use of superand dechlorination; determination of superchlorination dose; disinfection by superchlorination. Bibliography.

COAGULATION. Some Features in Coagulation of Water, H. P. Stockwell. *Can. Engr.*, vol. 76, no. 16, Apr. 18, 1939, pp. 80, 82, 84, 86, 88, and 90. Principles of coagulation for removal of colloidal impurities in natural water supply; most efficient coagulants; cotton plug strainers; treatment of colored surface water; colored impurities; European process for removing color.

CURRENT PURIFICATION PRACTICES. Purification of Water—The Trend of Current Practice, G. Baxter. *Surveyor*, vol. 95, no. 2470, May 26, 1939, pp. 687–690. Review of modern bacteriological standards of purity for drinking water; contamination dangers; physical standards; storage; slow sand filtration; rapid filtration; chlorination; ozonization; treatment with activated carbon.

FILTRATION PLANTS, BETHLEHEM, PA. New All Steel Filter Plant, J. T. Campbell. *Water Works & Sewerage*, vol. 86, no. 9, Sept. 1939, pp. 331–333. Features of circular, all-steel water filtration plant, built at cost of $29,000 for Citizens Water Company of New Bethlehem, Pa.; capacity of 720,000 gal per day.

FUNDAMENTALS. Fundamentals of Water Pretreatment, F. Bachmann. *Am. Water Works Assn.—J.*, vol. 31, no. 10, Oct. 1939, pp. 1691–1700, (discussion) 1700–1702. Removal of turbidity from water before filtration; advantages of pre-sedimentation in treatment of highly turbid waters; factors in flocculation; flash mixing; removal of algae and microorganisms; flocculation time; mechanical flocculation; effect of flocculation on detention time. Bibliography.

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STORAGE EFFECT. Aging of Reservoir Waters, L. T. Purcell. *Am. Water Works Assn.—J.*, vol. 31, no. 10, Oct. 1939, pp. 1775–1802, (discussion) 1802–1806. Study of changes in chemical and physical characteristics of water during storage in large reservoirs, with special reference to observations made at New Jersey storage reservoirs; reservoir turnover; temperature studies of Wanaque Reservoir; relationship between carbon dioxide and dissolved oxygen contents in Wanaque Reservoir; color trend; turbidity; variations in total nitrogen; iron and manganese content; hydrogen sulfide; microscopic organisms. Bibliography.

WATER WORKS ENGINEERING

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